THE TELEGRAPHIC JOURNAL AND

# Electrical Review.

Vol. XII.—No. 277.

## THE APPLICATIONS OF ELECTRICITY.

Hitherto the application of electricity to motive power in England has not advanced with very rapid strides, and we may expect to see France—as was the case with electric lighting—take the lead in this direction. It is evident, however, that the thoughts of some of our electrical engineers are gradually being turned away from the fascinations of electric lighting to the more useful development of electricity for the purpose of producing a cheaper and more convenient motive power than that obtainable by the means we have had at command up to the present time. It would be premature to ask any one to believe that we have yet reached such a stage of perfection in producing and utilising electricity for this purpose, as to induce the idea that nothing more remains to be accomplished; but enough has been done to demonstrate that the time has come for a thorough and exhaustive trial of the present means proposed for the employment of electricity as a means of motive power. Only when this has been done practically and on a large scale will our engineers be enabled to complete that which even now approaches perfection. Perhaps one of the most useful, easily applied, and comparatively inexpensive adaptations of electricity would be its employment as a propeller for tramway-cars. We all know what has been accomplished by Dr. Siemens and others towards this purpose, but with the one exception of the car devised by Prof. Ayrton last year, and which was tested at Leytonstone, we cannot call to mind a system in which either specially constructed permanent ways, or overhead conductors, were not required.

What is wanted, however, if tramway companies can be made to see the advantage of propelling their cars by electricity instead of horseflesh, is that their present permanent ways and plant should be made available with the new motive power. Electricity can, obviously, only be employed for this purpose through the agency of secondary batteries, and a demonstration to show their applicability to driving tramcars was, on Saturday last, given by the Electrical Power Storage Company. We were, unfortunately, unable to witness the successful portion of the day's experiments, which took place in the early morning, and, in common with a large assemblage of gentlemen interested in the subject, we had to content ourselves with an inspection of the electrical tramcar slowly drawn along by horses. The reason, however, is readily explained, and will at once relieve our readers of the probable impression that anything like an actual failure took place.

The tramcar was arranged to start, on the afternoon of the day above mentioned, on the lines of the West Metropolitan Tramway Company from Gunnersbury Station. It was to proceed to Turnham Green, and thence back to Kew Bridge. In the morning the car had been tested in the presence of Colonel Hutchinson, the Government inspector, on the Acton line, and a speed of six miles an hour or thereabouts had been attained. In the afternoon, however, on bringing the car on to the permanent way between Gunnersbury and Kew it was found impossible to work it satisfactorily, the gauge of the rails being about $\frac{1}{4}$ of an inch too narrow for the wheels of the car. We believe that the belts of the driving gear also got somewhat loose, but the cause first given is that said to account principally for the non-success of the afternoon's test.

Secondary cells of the Faure-Sellon-Volckmar type were stowed away under the seats of the car, and the propeller was a Siemens dynamo-electric machine. Some compensation for the disappointment occasioned by the drawbacks attached to the tramcar demonstration was afforded by the launch *Electricity* which had come up the River, electrically propelled, from Millwall. She carried many of the gentlemen present from Kew Bridge for short trips on the River, and great satisfaction was expressed at her performance. In a former number of this journal we gave a full and illustrated description of the *Electricity*.

The failure of the tramcar experiments in the presence of so many interested spectators is certainly a matter of regret. To those conversant with electrical science, and with what electricity may be made to accomplish, such a result is of little moment. But many, looking upon the subject from a commercial point of view, must have departed from the scene more than ever impressed with the uncertainties and eccentricities of electrical machinery.

Some will doubtless believe the reasons given for the partial failure, but even these will wonder why it was not known before that the gauge of the Acton line and that from Gunnersbury to Kew are not identical; and, again, if two horses could drag the car along, even at a walking pace, it might be questioned why a battery of accumulators could not, for a short time at all events, produce considerably more power than the horses. Others will probably put down the result to a breakdown in either the dynamo, secondary cells, or driving gear. In any case the matter will certainly be widely discussed, and it must be bitterly disappointing to those of the Electrical Power Storage Company's officers, who, after working night and day for the latter part of the week, should find their efforts frustrated just at the moment that the greatest success was desirable. Only on rare occasions does an important electrical experiment come off successfully, and one requires but a small acquaintance with the manner in which the arrangements for these tests are conducted to understand the reason. As far as we are concerned we believe the Electrical Power Storage Company is doing good work, and it should surely be worth the company's while to insure successful operations before bringing an experiment before the public notice.

We trust to be able in a short time to chronicle the complete success of the company's endeavours.

**The Electric Carbon Company (Limited).**—A petition for the compulsory winding-up of this company, which was already in voluntary liquidation, was heard by Vice-Chancellor Bacon in the Chancery Division of the High Court of Justice on Saturday. The petitioner described himself as a judgment creditor in respect of services rendered by him as solicitor. Mr. Hemming, Q.C., and Mr. Terrell were for the petitioner. Mr. Millar, Q.C., and Mr. Eustace Smith produced evidence to show that the petitioner was never employed by the company, and that the judgment which had been obtained in the Lord Mayor's Court was improperly obtained. Vice-Chancellor Bacon dismissed the petition, with costs.

## EXPERIMENTS ON A LOOPED TELEGRAPH LINE.

THE use of a looped telegraph line for testing the value of electrical or telegraphic apparatus is continual, and the advantages which it possesses over the method of testing at two ends of a single wire are obvious. In preliminary experiments where the inventor wishes to be able to adjust both the transmitting and receiving apparatus without making continual and profitless journeys backwards and forwards from one end of the line to the other, the looped wire is most useful—in fact, almost indispensable. It is, however, almost incredible that such experiments should be carried on in the way in which they usually are—namely, by employing the loop without using an earth. A more misleading method cannot well be imagined; in fact, we should have thought that common sense would have shown to any experimenter the utter fallacy of results obtained under such conditions. Experiments made in this way are unfortunately too common; we hear of telephone trials being made over a circuit of several hundred miles in length, and we are told that in spite of the extreme dampness of the atmosphere and the heavy consequent leakage, that the results obtained were remarkably satisfactory—in fact, that *better results were obtained when the weather was at its worst than when the atmosphere was dry.* This is brought forward as an incontestable proof of the superiority of the new invention. We would also refer our readers to the experiments of M. Marcel Deprez, accounts of which appear in our columns, and the fallacy of which we have pointed out.

FIG. 1.

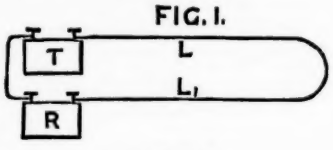



FIG. 2.

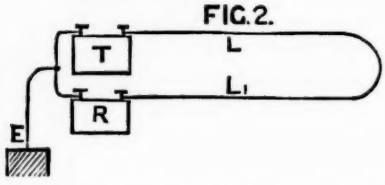



Fig. 1 shows the wrong, and fig. 2 the right, way of making an experimental test of a telegraphic or other electrical instrument on a looped circuit. In these figures L and $L_1$ are the wires forming the loop, T and R are the transmitting and receiving instruments respectively, and E is the earth. We think that every publicity should be given to this point for the guidance of experimenters. If we ever hear of experiments made over a line of telegraph the question should be asked—"Was the line a loop, and, if so, was earth used?" If a negative reply be given to the latter query, we may at once reject the experiments as being almost useless. Experiments made with a looped line without an earth are especially misleading as regards fast-speed telegraphic apparatus, since the important element of inductive retardation is absent. The number of cases which have come under our notice of delusive experiments of the kind are by no means few. It is not very long ago that a fast-speed apparatus from the other side of the water was tried with perfect success through a looped line of 400 miles long, a speed of *1,000 words a minute* being attained, *the weather being very damp;* in this case, however, *no earth was used.* The result, however, of putting on earth so as to render the conditions similar to those that would occur in actual practice was to bring down the speed to a little over *50 words a minute.*

**Underground Wires in New York.**—The Western Union Telegraph Company (of America) is about to establish an extensive underground system. The work is to commence in New York, where it is intended to lay a tube large enough to hold two hundred wires. In England it is said the tubes or pipes can rarely contain more than thirty wires.

## THE EXPERIMENTS ON THE TRANSMISSION OF POWER TO A DISTANCE AT THE CHEMIN DE FER DU NORD.

M. TRESCA has just presented to the Academy of Sciences, at its February 19th and 26th sittings, the results of two series of experiments made upon M. Marcel Deprez's machines established at the Chemin de fer du Nord, experiments upon which we expressed an opinion three weeks ago. We think proper, notwithstanding, to sum up in a table the mean results of both series of experiments as they were presented to the Academy by M. Tresca. All the mechanical measurements were made by M. Tresca, the electrical measurements of the first series by Dr. Hopkinson with Sir W. Thomson's new galvanometers; and the electrical measurements of the second series by M. Cornu with M. Marcel Deprez's apparatus placed at his service by the inventor. The two series of experiments relate to different velocities of the machines, and consequently to a greater amount of work obtained in the second than in the first case.

| | First Series. | Second Series. |
|---|---|---|
| Motive power in H. P. (by the dynamometer) | 6·21 | 10·395 |
| Generator, number of revolutions per minute | 590 | 814 |
| ,, difference of potential (volts) at terminals | 1290 | 1865 |
| ,, Electrical work in H. P. | 4·42 | 6·808 |
| Receiver, number of revolutions per minute | 365·8 | 595 |
| ,, difference of potential (volts) at terminals | 908 | 1485 |
| ,, electrical work in H. P. | 3·12 | 5·420 |
| Brake, work in H. P. | 2·03 | 3·304 |
| Intensity of the current in ampères | 2·559 | 2·687 |
| Practical mechanical return | 0·326 | 0·317 |
| Resistance of the generator (cold) 56 ohms | | |
| ,, receiver ,, 83 ,, | | |
| Diameter of the wire 1 millimetre. | | |

These experiments leave us in the same uncertainty as regards the influence of the leakage on the line, but they prove that these derivations have an actual existence, and that they can be by no means neglected nor a calculation accepted which takes no account of them. The resistance of the line, measured by a Wheatstone bridge with two Daniell cells—if our information is correct—was found to be 160 ohms, but it was less in the transmission experiments. In fact, had it remained 160 ohms it would have sufficed to apply Ohm's law to see that the difference of potential, or electromotive force, between the ends of the line must be equal to R I, which gives

For the first series: $160 \times 2{\cdot}559 = 409$ volts.
,, second ,, $160 \times 2{\cdot}687 = 430$ ,,

If we calculate this electromotive force by subtracting the electromotive force at the terminals of the receiver from that at the terminals of the generators (quantities *measured* by Messrs. Hopkinson and Cornu) we find:—

For the first series: $1{,}290 - 908 = 382$ volts.
,, second ,, $1{,}865 - 1{,}485 = 380$ ,,

It follows, necessarily, that the resistance inserted was less than 160 ohms to reconcile the direct observations with Ohm's law. This resistance in consequence of leakage is not more than

$\frac{382}{2{\cdot}559} = 148{\cdot}8$ ohms for the first series of experiments.

$\frac{380}{2{\cdot}687} = 141{\cdot}4$ ,, ,, second ,, ,,

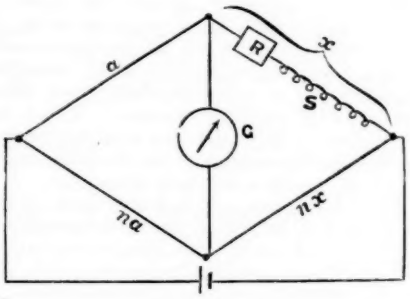
That is to say, a diminution of—

7 per cent. in the first series of experiments.
11·7 ,, ,, second ,, ,,

These results are quite conformable to theory; they show that the leakage becomes of more importance as the tension becomes higher. They do not seem to us to be any longer negligible when they have the effect of reducing by nearly 12 per cent. the resistance of the line in so original a method of connecting up as that adopted by M. Marcel Deprez to effect a transmission of power *to a distance.* The official experiments justify, therefore, our former criticisms, and give incontestable support to our objections. When will the experiments be made with a *true* line and a *true* distance?

## ON A METHOD OF MEASURING ELECTRICAL RESISTANCES WITH A CONSTANT CURRENT.*

IT sometimes happens that the resistance of a body appears to depend upon the strength of the current which traverses it. This is the case, for example, with the carbon filament of an incandescent lamp, with selenium, with mixtures of sulphur and carbon, and with microphonic contacts. Without assuming that these are altogether true resistances, it is nevertheless sometimes convenient to treat them as such, and for purposes of comparison it is clearly necessary that currents of known or constant strength should be used in their measurement. When the Wheatstone's bridge is employed in the usual manner, the current passing through the unknown resistance will, of course, depend upon the magnitude of this resistance, but by a simple modification of the common arrangement it is easy to insure having currents of uniform strength throughout a series of measurements.




In the figure, $x$, $n\,x$, $a$, $n\,a$, are the four arms of a Wheatstone's bridge; S is the unknown resistance, and R is a box of resistance coils which is inserted in the same arm. If E denote the electromotive force of the battery, B its internal resistance, and C the current which passes through the arm containing S, then when there is a balance

$$C = \frac{n}{n+1} \times \frac{E}{B + \dfrac{n\,(a+x)^2}{a+x+n\,(a+x)}} = \frac{n\,E}{(n+1)\,B + n\,(a+x)}.$$

From this expression we can find what value $x$ must have in order that the current through the unknown resistance may be of any definite strength. Having determined this value we insert resistance equal to $n$ times its amount in the arm, $n\,x$, and adjust the resistance of R until a balance is obtained. We then know that the resistance of R + S is equal to $x$, that the resistance required to be measured, S, is $x$ — R, and that a current of the desired strength, C, is passing through it. A second unknown resistance may now be substituted and measured as before simply by altering the resistance of R, with the certainty that when there is a balance the current is of the same strength as in the former case. The resistance, $n\,x$, remains unchanged throughout. It is, of course, necessary so to choose the values of $a$, $n$, and E, that $x$ may be greater than the resistance to be measured. Suppose, for example, that the electromotive force of our battery is 5 volts, its internal resistance 4·5 ohms, that $a$ = 10 and $n$ = 100, and that we desire a constant current of 1-10th ampère. Then we shall have—

$$\tfrac{1}{10} = \frac{500}{101 \times 4{\cdot}5 + 100\,(x+10)},$$

Whence $x$ = 35·455
= 35·46 nearly.

We therefore put a resistance of (35·46 × 100 =) 3,546 ohms in the branch, $n\,x$, and vary the resistance in the box, R, until the galvanometer indicates a balance. It is evident that the resistance of R and S together (= $x$) is then 35·46 ohms, and that a current of 1-10th ampère is passing through them. In order to find the resistance of S alone, it is simply necessary to subtract from 35·46 ohms the unplugged resistance in R.

The great advantage of this method over others that suggest themselves, lies in the fact that, since it is never necessary to close the circuit for more than a moment, the E. M. F. and resistance of the battery remain sensibly constant during a long course of experiments.

[An extremely simple method of measuring electrical resistances with a constant current, devised by Mr. H. R. Kempe, was given in the number of the ELECTRICAL REVIEW for July 1, page 475.—EDS. ELEC. REV.]

*Abstract of a paper read at the meeting of the Physical Society, March 10th, 1883, by Shelford Bidwell, M.A.

## ON THE ELECTRICAL TRANSPORT OF POWER.

By Dr. O. FRÖHLICH.

I WILL discourse on certain points of the electrical transport of power which have lately excited great interest, and in the first place on *the Relation between Attractive Force and Strength of Current, the Currents in the Iron Core and the Useful Work.*

The relation between attractive force and strength of current forms the subject of several memoirs of M. Deprez, especially in *La Lumière Electrique*, vol. vii., No. 48. From these memoirs we may select an elegant experiment by which M. Deprez shows that the attractive force depends on nothing else but the strength of current, and gives the construction of curves which represent the dependence of the attractive force on the strength of the current.

In these took place an electric transport of power by means of a primary and a secondary machine with their conductors. The secondary machine was fitted with a "Prony" brake, which maintained the attractive force at the same pitch by automatic regulation. The speeds of the machines were varied within very wide limits, and the strength of the current was continually observed, and was found to remain nearly constant.

The curves of the attractive force were determined by M. Deprez for different machines, all when driven; they yielded for small strengths of current a portion of a curve which followed approximately a quadratic law, afterwards a straight line. It must be remarked that in these experiments the influence of mechanical friction was eliminated by measuring the attractive force not at the armature but at the limbs if the magnet were made rotary.

Without in the least questioning the merit of this experiment, I must remark that in *L'Electricien*, June 15, 1881, I stated distinctly that the attractive force essentially depends only on the strength of the current, and I further characterised the knowledge of the relation between attractive force and strength of current as a means for finding the properties of a machine as regards the transport of power. Lastly, I examined the case of a constant attractive force.

I may be permitted to insert here the passage in question:—

"In order to meet all cases of practice, the machines must be known when not in their maximum condition, *i.e.*, when moving at low speeds and with currents of small strength.

"Abstracting from the induction currents, we have for the work the equation:—

$$A = n\,J\,M\,v.$$

(here $n$ denotes the number of coils on the armature; J the strength of the current; M the magnetism, and $v$ the speed).

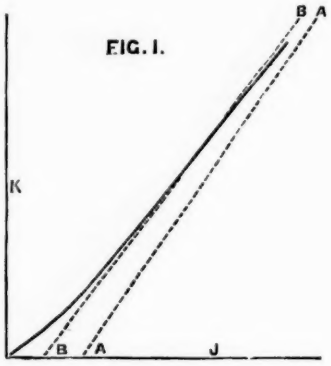
"In this equation we know that M is a function of the strength of the current J; consequently the product J M is merely a function of the strength of the current. This product is none other than the attractive force which exists in the machine at the circumference of the driving-wheel.

"In order to study this product we send into the machine currents of different strengths, the speed remaining the same, and measure the attractive force at the circumference of the driving-wheel, *e.g.*, with a Hefner dynanometer if the machine is driven, or by a Prony brake if it drives.

"If the current is constant (*e.g.*, at its maximum), and only

the speed varies, it follows from the above equation that the work (consumed or effected) is proportional to the speed. This important proposition is modified but little if the induction-currents are taken into consideration. By means of this proposition we may deal with cases where the attractive force to be furnished is constant, but the speed variable. This is the case in pumps, in tool-machines, and in level electric railways. It is possible to calculate beforehand the changes of speed in the secondary machines which are derived from the changes of speed in the primary machines in consequence of changes of resistance. For a horizontal electric railway, *e.g.*, it follows from our proposition that the speed decreases proportionally to the mutual distance of the two machines, and this decrease may be readily calculated." (I must remark that in the French text the word "travail" was repeatedly used for attractive force, whilst my original text always contained instead the expression "force."

FIG. I.




Carrying out the contents of this memoir there were made in the establishment of Siemens and Halske, as can be proved from their "Journal of Experiments" on September 20th and following days, 1882, certain experiments in which one and the same machine was submitted both when driven and when driving, to attractive forces differing as far as possible and all the electric and mechanical magnitudes, were determined.

Let us first consider in general the results of those experiments :—

The course of the curves for the attractive force as obtained from these experiments is similar to those of Deprez (fig. 1); they show at first the character of a curve of the second degree; the curvature diminishes very rapidly and soon becomes very small, so that for practical purposes as regards the strengths of currents usually occurring the curve may be very well replaced by a straight line which does *not* pass through its initial point.

This course is explained if we apply to the magnetism (M) the interpolation formula which I used in my researches of November, 1880 (see *Electrotechnische Zeitschrift*, vol. ii., p. 139), namely,

$$M = \frac{J}{a + b\,J};$$

for the attractive force, K, we have (disregarding the currents in the iron core),

$$K = n\,J\,M,$$

consequently,

$$K = n\,\frac{J^2}{a + b\,J}.$$

For small strengths of current $b\,J$ is small in comparison with $a$, and we have, therefore,

$$K = \frac{n}{a}\,J^2\left(1 - \frac{b}{a}\,J\right),$$

essentially a curve of the second degree, since the quantity

$$-\frac{b}{a}J$$

is small compared with J.

For great strengths of current in which the magnetism approaches the maximum, $a$ is small in comparison with $b\,J$ and

$$K = n\,\frac{J^2}{b\,J\left(1 + \frac{a}{b\,J}\right)} = \frac{n}{b}\,J\left(1 - \frac{a}{b\,J}\right) = \frac{n}{b}\left(J - \frac{a}{b}\right)$$

*i.e.*, a straight line which for the value

$$J = \frac{a}{b}$$

intersects the axis of the abscissa. This straight line is the asymptote to which the curve is continually approximating, but which it reaches only at an infinite distance.

The straight line which in medium strengths of current can with sufficient accuracy be substituted for the curve is a tangent which in mean values of the strength of the current is drawn on the curve.

If we place together the curves which characterise a dynamo machine we find those of the current, of the magnetism, and of the attractive force. The curve of the current is that representing the dependence of the current on the relation between speed and total resistance, and concerning which we showed that from it the behaviour of a dynamo machine may be completely determined beforehand if it works only with external resistance. This is the only method of exhibiting this behaviour by a single curve. In every other mode of representation the electromotive force is a function of two variables, but here of one only.

The curve of magnetism, which I also drew up in 1880, and which a year later M. Deprez named "*la caractéristique*," represents the dependence of the magnetism on the strength of the current. It serves especially to represent the magnetic behaviour of a machine, both the magnetism of the limbs and the demagnetising action of the armature.

Now comes in addition the curve of attractive force. As already explained in our article in *L'Electricien*, it is this curve which characterises the machine as far as the transfer of power is concerned, and it has therefore a direct practical value. Theoretically it is nothing essentially new, for, as we saw above, this curve (disregarding deviations to be presently discussed) can be directly derived from that of magnetism of multiplication with $n$ J, and inversely the curve of magnetism can be derived from that of attractive force.

The above considerations, which serve only to give a general glance, become complicated when we look at the difference shown by the machine when it drives and when it is driven. This difference was made clear in part by the experiments of Siemens and Halske in 1880, and especially by those in 1882 already mentioned, and which I am permitted here to communicate.

In these experiments one and the same machine, with the same arrangement of the commutator, was exposed, both when driving and when driven, to attractive forces differing greatly, and all the electrical and mechanical magnitudes were measured. If the machine was driven by a steam-engine the attractive force was determined as difference of the tension of the driving bands by means of a Hefner dynamometer; when it was driving secondary a Prony brake was applied.

The results of these experiments are given in the following table.

The electromotive force was determined from the polar tension, the product, strength of current, ×, resistance of the machine being added when the machine was driven, but subtracted when it was driving.

The strength of the current was determined by measurement of the tension at a known resistance; all electric measurements were executed by means of a torsion galvanometer.

We see that the individual experiments agree among themselves the more as the attractive force is greater. With small attractive forces there occur considerable fluctuations due to the circumstance that then the influence of the friction of the brushes, the resistance of the air and of the currents in the iron core are much greater in proportion than with great electric attractive forces.

On this account it is to be supposed that the experiment of Deprez with a constant attractive force gives a constant current only so long as the attractive force is relatively

large, but that in case of small attractive forces there will occur considerable fluctuations of the current at different speeds.

WHEN THE MACHINE IS DRIVEN.

| K Active Force in Kilos. | | J Strength of Current in Amperes. | | P Polar Tension in Volts. | E Electromotive Force in Volts. | n Revolutions per minute. | M Magnetism = E/n | |
|---|---|---|---|---|---|---|---|---|
| Single values. | Mean. | Single values | Mean. | | | | Single values. | Mean. |
| 5·5 | 5·1 | 1·68 | 2·83 | 4·4 | 5·0 | 376 | 0·0133 | 0·0194 |
| 5·3 | | 3·96 | | 18·4 | 19·7 | 815 | 0·0242 | |
| 4·5 | | 2·86 | | 19·9 | 20·9 | 1,008 | 0·0207 | |
| 9·0 | 10·6 | 6·82 | 9·53 | 18·0 | 20·3 | 415 | 0·0489 | 0·0606 |
| 12·5 | | 10·2 | | 28·6 | 32·0 | 460 | 0·0696 | |
| 10·5 | | 10·7 | | 46·5 | 50·1 | 795 | 0·0630 | |
| 10·2 | | 10·5 | | 54·5 | 58·0 | 951 | 0·0610 | |
| 14·8 | 14·8 | 14·3 | 14·3 | 58·8 | 63·6 | 819 | 0·0777 | 0·0777 |
| 21·5 | 21·3 | 19·5 | 19·8 | 56·4 | 62·9 | 646 | 0·0974 | 0·0983 |
| 20·5 | | 18·6 | | 70·1 | 76·3 | 800 | 0·0954 | |
| 21·9 | | 21·2 | | 50·9 | 58·0 | 568 | 0·1020 | |
| 27·4 | 25·8 | 22·5 | 22·1 | 34·0 | 41·5 | 390 | 0·1060 | 0·104 |
| 24·3 | | 21·3 | | 62·9 | 70·0 | 702 | 0·0997 | |
| 25·6 | | 22·5 | | 38·7 | 46·2 | 437 | 0·1060 | |
| 32·7 | 29·6 | 25·3 | 24·3 | 42·7 | 51·1 | 440 | 0·116 | 0·107 |
| 28·2 | | 24·1 | | 56·9 | 64·9 | 622 | 0·104 | |
| 27·9 | | 23·4 | | 70·5 | 78·3 | 774 | 0·101 | |
| 35·0 | 34·0 | 29·8 | 29·1 | 67·3 | 77·2 | 600 | 0·129 | 0·122 |
| 33·0 | | 28·4 | | 80·9 | 90·4 | 527 | 0·115 | |
| 44·0 | 44·0 | 36·6 | 36·6 | 51·3 | 63·5 | 513 | 0·124 | 0·124 |

WHEN THE MACHINE DRIVES.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | 10 | 13·8 | 13·3 | 98·5 | 93·9 | 1,240 | 0·0757 | 0·0745 |
| 10 | | 18·8 | | 74·2 | 69·6 | 953 | 0·0730 | |
| 10 | | 12·4 | | 69·0 | 64·7 | 870 | 0·0744 | |
| 10 | | 13·8 | | 55·0 | 48·4 | 633 | 0·0765 | |
| 10 | | 12·7 | | 40·9 | 36·7 | 505 | 0·0727 | |
| 20 | 20 | 21·0 | 21·0 | 115· | 108· | 1,120 | 0·0964 | 0·0988 |
| 20 | | 21·8 | | 83·8 | 76·5 | 790 | 0·0969 | |
| 20 | | 21·1 | | 87·4 | 80·4 | 770 | 0·1040 | |
| 20 | | 19·9 | | 64·7 | 58·1 | 600 | 0·0968 | |
| 30 | 30 | 25·6 | 28·1 | 99·7 | 91·2 | 870 | 0·105 | 0·110 |
| 30 | | 27·9 | | 116· | 107· | 1,026 | 0·104 | |
| 30 | | 30·0 | | 96·8 | 86·8 | 753 | 0·115 | |
| 30 | | 28·8 | | 112· | 102· | 883 | 0·115 | |
| 40 | 40 | 35·4 | 36·8 | 98·5 | 86·7 | 782 | 0·111 | 0·125 |
| 40 | | 37·9 | | 102· | 89·4 | 653 | 0·137 | |
| 40 | | 37·1 | | 89·0 | 75·6 | 593 | 0·127 | |

If we plot out the values of the magnetism and of the attractive force as a function of the strength of the current —as resulting from these experiments—we obtain for the attractive force two different curves (fig. 2), one for the

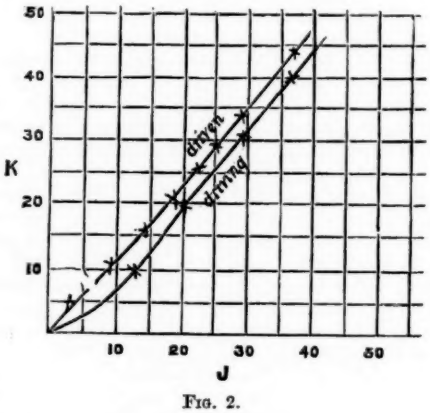



FIG. 2.

driven condition and one for the driving; the difference between both curves shows that for the same strength of the current the attractive force is greater by about 10 per cent. in the driven than in the driving condition. For magnetism we have essentially only one curve (fig. 3), for if we mark the points for the driven state (marked X) and connect them by a curve, it appears that the points for the driving state (marked O) are divided with approximate equality on both sides of the curve, so that it is essentially applicable to either condition.

As for the difference in the attractive force, it is self-evident that a part of it depends on the mechanical resistance opposed to the movement of the keeper, namely, the friction of the brushes and the resistance of the air. In the driven the mechanical attractive force is equal to the sum of the electrical and of those frictions; in the driving state it is equal to the difference of the electrical and of the force of friction; if, therefore, the electrical force is the same in both cases, the actual attractive forces must be different and in the manner which is really observed.

Besides the mechanical frictions the attractive forces of the currents in the iron core come into play. In the above experiments they have not been determined, but from

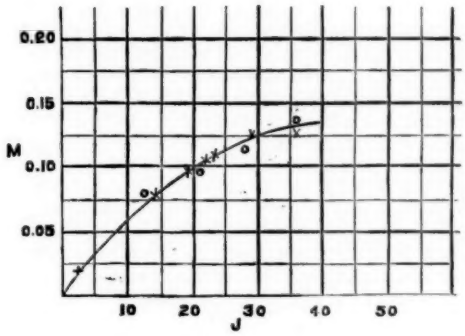



FIG. 3.

the analogy of other measurements it must be assumed as not less than 3 per cent. The mechanical action of these currents in the iron core is, as we have already shown, quite similar to that of the mechanical friction.

The result drawn from the above experiments, as regards magnetism, viz., that it has in both conditions essentially the same value, differs from that obtained from the experiments of 1880.

Those experiments showed differences of magnetism in the two conditions up to 20 per cent., the magnetism being greater in the driving than in the driven condition. We showed then that the magnetising influence of the currents in the iron core must have such an effect, for the currents in the driven state have the same direction as the currents in the armature-wires; in the driving state the reverse holds good (*see* fig. 4). The outer circle represents the copper wires; the inner, the iron wires of the armature. The latter are supposed to be coiled in the same manner as the former. Hence it follows that the magnetic action of the currents in the iron core in the driven state is similar to that of the currents in the copper wires, whilst in the driving condition

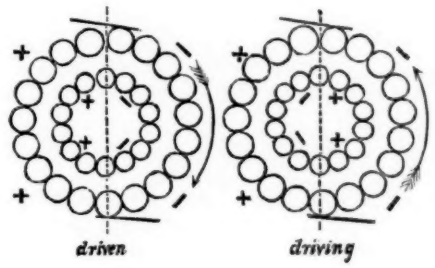



FIG. 4.

it is opposite. Hence in the driven state these currents decrease the magnetism, but increase it in the driving condition. The experiments of 1880 have been calculated on this supposition, and brought into agreement with theory.

If more recent experiments show little or no difference of the magnetism in the two conditions, this is explained from two causes:—

1. In the experiments of 1880 the position of the commutator was variable, each commutator in each experiment being set in the best position. Further, two different machines were examined, the one in the driving and the other in the driven state. In the more recent experiments one and the same machine, with a constant position of the commutator, has been examined in both conditions.

2. The currents in the iron core in the machines of 1880 were decidedly more powerful than in that examined in 1882. On the former occasion a decided magnetic influence of these currents may have prevailed, which in the year 1882 was imperceptible.

The explanation of the experiments of 1880 is modified in the results of the above-described experiments, merely in so far that probably a part of the difference in the magnetism in the two conditions may be referred to the position of the commutator. The theory then proposed remains untouched by these results, and the present experiments merely show that in the machine examined the magnetising effect of the currents in the iron core (or the value of the constants, $\eta$) is insignificant.

The influence of these currents upon the attractive force (constant $p$) is not directly connected with their magnetising influence. It is also in the above experiments not unimportant, and in the machines examined in 1880 it was of very appreciable value. This mechanical influence of the induction currents is certainly the most important, and without taking it into consideration it would not have been possible to explain the numerous and much varied experiments of 1880, and even in machines in which those currents are developed less powerfully their attractive force must always be taken into consideration in order to explain the differences between mechanical and electrical effective work.

A simple experiment, given by me in the above-mentioned number of *L'Électricien* shows this attractive force.

If the plates of the machine to be examined are magnetised by a second machine, and if the armature is allowed to rotate without applying the brushes, we can measure directly the attractive force of the mechanical frictions and of the induction currents in the iron core, *e.g.*, by means of a Hefner dynamometer. If the circuit of the magnetising machine is opened there remains merely the attractive force of the mechanical frictions, and both influences may be determined separately.

In experiments of this kind which have been made at Siemens and Halske's works upon various machines not built with especial care in this respect, there was found for the work of the induction currents from 3 to 15 per cent. of the maximum work of the machine. This result is intelligible if we take the construction of the iron core into consideration.

We cannot assert that no machines exist in which these currents do not occur, or that such cannot be constructed. Still, the better the iron wires are insulated the more magnetism is lost, whence many constructors prefer to apply a mere scanty insulation. If we glance over the series of machine constructions, from the Double-T machines to the most recent, we have before us all possible cases as far as the currents in the iron core are concerned.

The Double-T machines (Siemens' armature) have generally armatures of wrought-iron, and it is known that, even when no current circulates in the armature wires, they very soon warm on rotation. It is even asserted that such an armature consumes more work in rotation without a current in its wires than with one.

Certainly in this case the work of the iron core is as great as or greater than that of the copper wires of the armature.

On the other hand, it cannot be doubted that by a suitable construction of the massive iron parts and by a good insulation of the iron wires, an almost total absence of the currents in the iron core can be effected.

Between these extremes—the very trifling currents in the latter case and the enormous currents in the former—the machines of the present day offer various gradations, especially armatures with imperfectly insulated iron wires and those of cast-iron with notches.

With the difference of the magnetisms a question is connected which has lately formed the subject of a controversy between M. Maurice Lévy and M. Deprez, whether the electromotive force of a dynamo machine, the strength of the current being equal, is exactly proportional to the speed, or if another quantity must be added containing the square of the speed.

If translated into our terminology, the same question rises if the magnetism for equal strengths of current depends on the speed or not.

M. Lévy maintains that such a second quantity must be present and be of considerable value, and he believes that our experiments of the year 1880 render the existence of such a quantity probable. M. Deprez, on the other hand, maintains that such a quantity must be too small to be perceptible in experiments.

In the treatise of 1880, I have shown that when induction currents are present in the iron core, they must produce a difference in the magnetisms in the driven and the driving conditions, so that in the former the magnetism is :

$$M_1 = M\,(1 - \eta\, v)$$

and the electromotive force :

$$E_1 = n\, M\,(v - \eta\, v^2)$$

but in the driving condition

$$M_2 = M\,(1 + \eta\, v)$$

and the electromotive force :

$$E_2 = n\, M\,(v + \eta\, v^2)$$

(M denotes here the magnetism in the absence of induction currents in the iron core, $v$ the speed, and $\eta$ a co-efficient).

The difference of the electromotive forces in the two conditions would hence be :

$$E_2 - E_1 = n\,(M_2 - M_1)\,v = 2\,\eta\, n\, M\, v^2.$$

Hence it appears that according to our theory, the electromotive force for equal strengths of current is not strictly proportional to the speed, but that another quantity intervenes, containing the square of the speed and depending on the magnetising influence of the induction currents in the iron core.

According to the experiments of Siemens and Halske in 1880, this quantity seemed to possess a considerable value. It is, however, probable that the influence then ascribed to the induction currents is in part due to the changes in the position of the commutator. According to more recent experiments, it is inappreciable, and the electromotive force is proportional to the speed.

We will now draw conclusions from our considerations as to that magnitude of the electric transfer of power, which is the most important of all, and has been latterly much discussed—the mechanical useful work.

Latterly, especially in consequence of the experiment of M. Deprez at Munich, we have often heard simple methods of calculation spoken of by which the useful work may be approximately estimated without the necessity of undertaking the measurements required for its exact determination. These methods of calculation consist in the assumptions that the mechanical useful work is approximately equal to the relation of the speeds of the two machines, or to the relation of the electromotive forces.

It cannot be disputed that the practical man often feels the need of such simple methods of calculation as he has often neither time nor opportunity to undertake the mechanical measurements, but that caution is here requisite appears from the example of the Munich experiment.

The calculation from the proportion of the speeds is decidedly the worst. It possesses the same faults as the method of calculation—to be discussed below—with the proportion of the electromotive forces. But there is in addition another source of error, practically almost of more importance than the others, *i.e.*, the influence of the position of the commutator at the secondary machine.

This position has so considerable an influence upon the speed of the secondary machine that by means thereof it is easy to make the secondary machine run more quickly with a weak current than the primary. If therefore the position of the commutators in both machines is not exactly alike, the calculation from the proportion of the speeds gives worthless results.

The other calculation from the proportion of the electromotive forces approaches nearer the truth. This relation is equivalent to the electric useful work, *i.e.*, the proportion of the electric work in both machines. Both the conversion of mechanical into electrical work in the primary machine and the reconversion of electrical into mechanical work in the secondary machine involve losses, produced by mechanical friction and the occurrence of currents in the iron cores. The electric useful work must be always greater than the mechanical. This appears from the fact that the electrical useful work with very weak currents may reach nearly 100 per cent., whilst the mechanical work never exceeds 60 per cent. The difference between both is the greater the feebler the current and the higher the speed.

The more powerful the current the more the work of

mechanical friction and of currents in the iron core disappears in opposition to the electric work, and in such case the relation of the electromotive forces, and also that of the speeds, can be used as a rough approximation to the calculation of the mechanical useful work.

The divergencies of both these relations from the mechanical useful work have been already given by me in the year 1880, accompanied by suitable formulæ. The following formula possesses an especially practical value. It contains only electrical magnitudes, and the mechanical useful work (N) developed from the electrical, $\frac{E_2}{E_1}$:—

$$N = \frac{E_2}{E_1}\left\{1 - \frac{p}{c\,J}(E_1 + E_2)\right\}.$$

It is available for any position of the commutator, and requires merely the determination of the magnitude, $p$, which depends on the currents in the iron core.

With this formula a great number of useful results have been calculated under all possible conditions, and the results were sufficiently concordant for practice.

In this formula the mechanical frictions are disregarded, but in the experiments they had a much less influence than the currents in the iron core.

If $R_1$ $R_2$ are the magnitudes of work derived from these frictions, then $A_1 = c\,J\,E_1 + p\,E_1^2 + R_1$; $A_2 = c\,J\,E_2 - p\,E_2^2 - R_2$, and the mechanical useful work,

$$N = \frac{A_2}{A} = \frac{E_2}{E_1}\left[1 - \frac{1}{c\,J}\left(p\,(E_1 + E_2) + \frac{R_1}{R_1} + \frac{R_2}{E_2}\right)\right].$$

*(To be continued.)*

## THE ACTION OF THE MICROPHONE.

By A. STROH.

AN experiment, which may help to throw light upon the action of the microphone, was described by Mr. Stroh during a discussion on "The Theory of the Microphone" which followed the reading of Mr. Munro's paper at the Society of Telegraph Engineers and of Electricians, on the 8th inst. This experiment is as follows:—

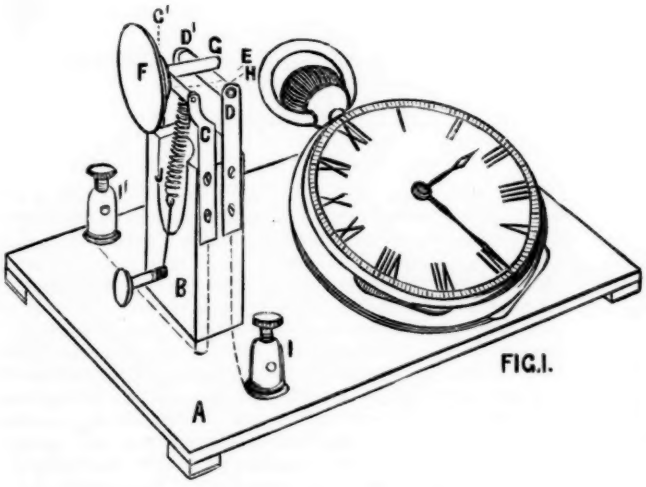


FIG. 1.

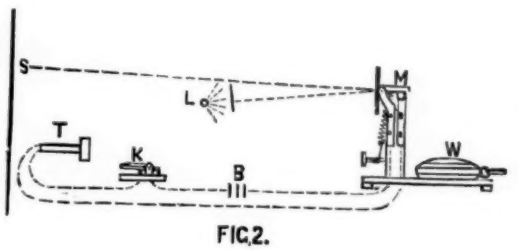


FIG. 2.

Fig. 1 represents a very small and delicate form of Prof. Hughes' so-called hammer-and-anvil microphone.

On a thin board, A, is fixed a little block, B, which serves to hold four brass uprights, C C' and D D'.

A light spindle, E, provided with a pivot or knife-edge at each end, rests on the uprights, C and C'. Attached to the spindle, E, on one side is an exceedingly light concave reflector, F; while on the other side, and in good electrical contact with the spindle, is a thin rod of carbon, G. The latter rests at right angle on another rod of carbon, H, which is firmly fixed in the two brass uprights, D and D'.

Terminals I and I' communicate each with a pair of the brass uprights. A little spiral spring, the tension of which can be regulated by a small thumb-screw, serves to keep the two carbons in microphonic contact.

A loud-ticking watch, or other source of sound, is placed on the board, A.

The general arrangement of the experiment is shown in fig. 2. M is the microphone just described. A lime-light, L, is placed behind a little screen with a small round hole in it, across which is stretched a fine wire, so that the image of the latter is thrown by the reflector of the microphone on a wall or screen at S, where a graduated scale may be fixed, and where, by means of the image of the fine wire, any deflection can be easily read.

A downward movement of the reflected spot of light on the screen, S, indicates a separation of the carbons at the point of contact, while an upward movement would be due to an approach of the carbons towards each other.

A telephone, T, a make-and-break key, K, a battery, B, and the microphone, M, are joined in circuit. The adjustment of the latter is now made so that the ticking of the watch is heard as loud as possible in the telephone, T, while the observer has one hand on the key, K, and is also watching the spot of light at S.

At the instant when the current is broken at K the spot of light moves upwards, not sluggishly, but suddenly and sharply, the sound in the telephone of course ceasing at the same moment.

On making contact again the spot of light quite as suddenly returns to its former position, while the ticking is heard again.

The distance through which the spot of light moves is very small, but the action is so decided and unfailing that there is no difficulty in observing it.

It happens sometimes that microphones are uncertain in their action, and will suddenly fail to work, and in observing the spot of light during some such failures, it was found that it jumped upwards at the same moment when the telephone became silent, and returned as soon as the microphone was brought into action again by a tap on the table.

It was *only* during the clear working of the telephone that the spot of light remained steadily deflected downwards, which seems to indicate that during the time when the carbons are really in what is called microphonic contact, they are not in contact at all, or at all events, that there is a repellant action at the point of contact.

With a single element of a small bichromate battery in the circuit, the deflection was hardly perceptible; but with three elements the spot of light moved through one millimètre between making and breaking.

When a greater number of elements was used the deflection was also greater, but there was much hissing, and the spot of light was not steady.

With three elements the experiment succeeded best; with this number the ticking of the watch could be heard loudly and clearly without any hissing.

In order to arrive at an estimate of the distance which appeared to exist between the two carbons at the point of contact during their action as a microphone, it may be mentioned that the distance between the screen, S, and the reflector was six mètres, and that between the fulcrum and point of contact of the microphone six millimètres, so that the former distance was 1,000 times greater than the length of lever in the microphone. This figure has to be doubled on account of a reflected beam of light moving through double the angle of the reflector itself.

The total deflection on the screen, S, being one millimètre, the distance to which the upper carbon was repelled during microphonic action, under the circumstances described, was therefore 1-2000th part of a millimètre.

## PROCEEDINGS OF SOCIETIES.

### The Society of Telegraph Engineers and of Electricians.

AN ordinary general meeting of this society was held on Thursday, March 8th, Mr. Willoughby Smith, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new, and proposed new, members read, a paper was read by Mr. J. MUNRO on "New Telephone Transmitters." The author commenced his paper by stating that, in order to avoid the Edison patent, it was necessary to avoid the use of carbon, and probably even of any semi-conductor. The author was of opinion that the action of the microphone was not due to the diminution of resistance at the points of contact by pressure, causing greater or less area of surface contact, according to the current theory at that time. It seemed to him that the film of air between the contact points played an important part in its action, and that the electrodes of a microphone might be of any conducting substance—for example, metals—without destroying its peculiar power of transmitting sounds. What kind of metal to use and what particular form to give it, in order to get good articulation and durability of action, were questions which only experiment could answer. In working out any ideas on the subject, the author worked in conjunction with Mr. Benjamin Warwick. One of the first ideas tried is shown in fig. 1, and though it proved a failure it was instructive in one particular. A B is a fine short platinum

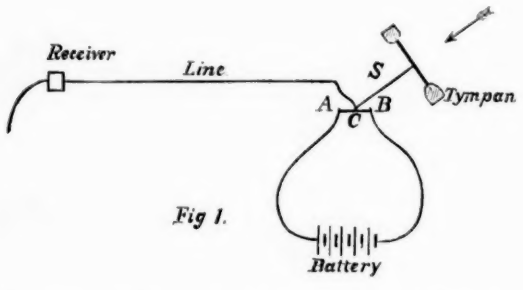



*Fig 1.*

wire connected between the poles of a battery, and carrying a sliding contact or chariot, C, which is connected by a light but stiff stylus, S, to the centre of a mica drumhead or tympan. On speaking against the tympan in the direction of the arrow, the stylus shoots to and fro like the recording pen in Barlow's logograph, and slides the chariot, C, up and down the wire to points of greater or less potential. This chariot is connected to one end of the line, which has a receiver at the other end. When there is no circuit through the line, and the device acts by varying the potential of the transmitting end of the line, a Dolbear receiver or a condenser would be used; but if a shunt circuit is formed between the chariot, C, and one pole of the battery through the "primary" of an induction coil, while the "secondary" is in circuit with the line, a Bell receiver may be used. On trying this plan, however, it was found that the current varied too regularly, owing to the chariot always moving in contact with the wire. The strength of current was thus varied by easy grades and was not quickly and abruptly changed, as it needs must be in a good transmitter, so as to render all the sudden irregularities of speech vibration.

Tried with a tympan of mica or ferrotype plate, placed horizontally, and having a short angular stylus projecting upwards from its middle and rubbing up and down a short platinum-iridium wire in circuit with seven Bunsen cells, imperfect speech was heard in a Bell telephone connected between the stylus and one pole of the battery; but it might have been due to the microphonic contact between the stylus and wire. A mercury drop, enclosing the wire, to act as a chariot, did not give articulate sounds. Neither did the oscillation of mercury up and down a wire in a capillary tube. The sudden rise and fall, the sheer descent of current, which is required for the transmission of speech, could not be given by such a device. The use of wires in these experiments led the author to the idea of employing two light wire gratings resting on each other under slight pressure, and forming a metal microphone with multiple points. It seemed that the light open structure would allow the sound-waves to agitate the contacts without the intervention of a tympan, and something after the manner of an Æolian harp. Fig. 4 is a transmitter made on this plan. It consists externally of a wooden box, B, having a mouthpiece, M,

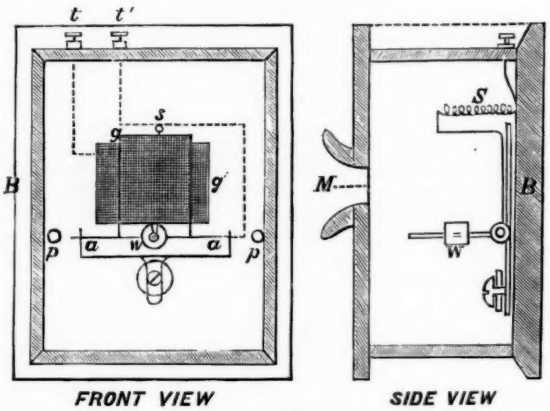



*Fig. 4*

**THE GAUZE TRANSMITTER.**

closed by a piece of match-wood. Inside the box is the microphone, or "current-regulator," which consists of a piece of ordinary iron-wire gauze, *g*, lightly pressed against another piece, *g'*. The back piece of gauze, *g'*, is fixed to to the back of the case, but the front piece, *g*, is carried by a loose axle, *a a*, supported in bearings at each end. From the axle projects an arm, carrying a movable counter-weight, W, and the downward pull of this weight, tending to lift the front gauze off the back, is balanced by the force of an adjustable spring, S. The pressure on the microphonic contacts is regulated by this means. The stops, *p p*, serve to limit the sidelong play of the axle carrying the movable gauze, when it is found convenient to shift the position of the latter in adjusting the instrument. The current enters and leaves the regulator by the terminals, *t t'*. A small induction coil (not shown) is usually inserted between the transmitter and the line, the "primary" of the coil being in circuit with the battery and the regulator, while the "secondary" is in circuit with the line-wire and receiving telephone. On speaking into the mouthpiece in the usual manner the air-waves set up by the voice pass through the two gauzes and agitate the contacts between them, thereby modifying the current so as to make the telephone repeat the words. The match-board diaphragm is not an essential, as the sound-waves act directly on the contacts, but it is

useful in screening the regulator from the rudeness of the breath, and fixing the distance at which the speaker should keep. A grating across the mouthpiece answers almost as well. The pole of a permanent magnet presented to the gauzes will hold them together with a force depending on the nearness of the pole. When an electro-magnet, E, is used, as in fig. 5, the current itself may traverse the coil of

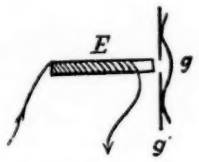



*Fig. 5.*

the magnet, and hold the gauze, *g*, against *g'* with a force which will be stronger when the current is stronger, and thus enhance the pressure of the sound-waves, so as to give a more decisive action. It was found that the gauze may be either clean or tarnished, provided the rust upon it is not so thick as to make the surfaces adhere to each other. Two pieces of gauze are not essential to the transmission of sounds, as one piece resting on a flat metal plate, either plain or corrugated, will answer; so also will two thin metal plates with roughened surfaces. But gauze is the most convenient and successful material.

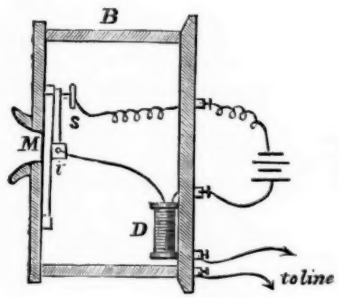



*Fig 6.*

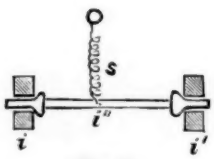



*Fig 7.*

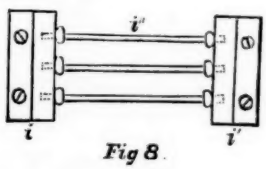



*Fig 8.*

**THE BAR TRANSMITTER**

Another type of metal transmitters is shown in figs. 6, 7, and 8. There B is the case, as before, with a match-board screen, M, and behind it a flat sounding-board carrying a metal microphone, *i*, with its adjusting spring, S. An induction coil, D, having its "primary" in circuit with the microphone and battery, and its secondary in circuit with the line, is also contained in the case. The microphone is formed of a light metal bar, *i''*, resting by its ends in holes drilled in two metal blocks, *i i'*, figs. 7 and 8. An adjusting screw, *s*, regulates the pressure between the bar and its bearings. The metal found most suitable is common cast-iron, which may either be clean or slightly tarnished.

A third type of transmitter is shown in fig. 9. In this the current-regulator consists of metal granules, *m*, enclosed in a box between two metal plate-electrodes, *e e'*, connected to the terminals, *t t'*. The back of the box may either be of wood and the front of wire gauze, or both may be of sonorous wood. Iron or brass filings and turnings serve as metal grains, especially those with a good deal of inherent resilience, or spring; but a pile of small ¼-inch screw nails, or a grit of "spongy iron," give better results. Spongy iron, having a rough surface, approximates to carbon in its action.

A fourth type of transmitter is that shown in fig. 10, where B is a box, as before, with a mouthpiece, M, and an induction coil, D. The mouthpiece in this case is closed by a tympan connected at its centre to a metal chain, or strip of chain mail, *c c'*, which is strained by the springs, *s s'*, and the tie, *f*. This chain is the current-regulator, and is

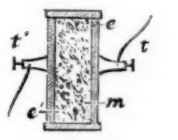



*Fig 9.*

**THE GRAIN TRANSMITTER.**

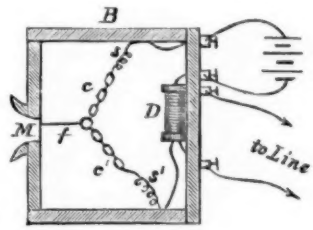



*Fig 10.*

**THE CHAIN TRANSMITTER.**

traversed by the current. Between every two links there is a microphonic joint. The vibration of the tympan, on speaking in front of it, tightens or slackens the chain, thereby operating the current-regulator and transmitting the sounds. The pressure between the links, which by preference are of iron, is regulated by adjusting screws.

Mr. MUNRO next read a "Supplementary Note on the action of the Microphone." The original theory of Edison was that the internal resistance of carbon was reduced by pressure. Sir William Thomson supported the theory that the action is due to an increase or diminution in the area of surface-contact produced by increase or diminution of pressure. Mr. Preece considers that the microphone acts by heating at the points of contact when the current passes. It does not seem probable, however, that the variations of temperature can be so quick and sudden as the transmission of sonorous currents requires. Another reading of the theory may be that the heated points are of a spongy nature, and more sensitive to pressure; but here again it is difficult to see how the effect can be in simple ratio to the pressure. A fourth theory, supported by Professor Hughes and Professor Blyth, and probably first intimated by Mr. F. H. Varley,* attributes the action of the microphone to a small arc formed between the points, and this appears to be a likelier hypothesis. The author, however, proposes a modification of it, and, instead of an "arc," in the ordinary sense, considers the cause a "silent" discharge through the film or stratum of air or liquid between the points, after the manner of a lightning guard. A silent discharge going on between numerous tiny projections on the carbon points, which in this respect resemble the corrugations or spines in two well-known forms of plate-lightning arrestors used in telegraphy. We have to figure to ourselves the microphone points covered with irregular projections which touch each other, but are bathed in the surrounding air and ether. These projections, like the points of a lightning arrestor, are constantly discharging little jets of current from one to the other across the air between. But the action of the sound-waves is to move them to and from each other, thereby increasing and lessening the width of the air stratum, and varying the strength of the discharge.

The "boiling" or "buzzing" of a metal transmitter not properly adjusted reveals this "silent" discharge from a multitude of points. If the sonorous waves are too violent, the points are separated too far, the contact is broken, and a sharp click is heard in the telephone. This is due to the stoppage of the discharge. It is the sound heard on a larger scale on stopping the current in an arc lamp. It seems an effect of the rarefied arc rather than the heated points, for if it were due to the shrinking of the points it would be observable in an incandescent wire on stopping the current through it. The author's opinion is that the rarefaction of the air and ether, caused by the discharge, is the true source of this effect. When the current suddenly ceases, the rarefied gas collapses, and equilibrium of fluid-pressure is restored. The application of heat, by the spirit flame, to

* See ELECTRICAL REVIEW, vol. vi., p. 404.

two pieces of wire gauze in contact, increases the microphonic action between them. When the flame is applied to the metal so as to heat the contact, tapping, as heard in the telephone, becomes louder, and gradually dies off when the flame is removed. Hot metals and flame are known to discharge electricity better than cold metals, and hence, in all probability, the slow discharge of the microphone is accelerated by this means.

The recent experiments of Mr. Shelford Bidwell appear to bear out the theory that the microphone acts mainly through the air discharge between the points. Thus he finds that the resistance of the contacts varies greatly with the strength of current when the pressure is small, and very slightly when it is great—that is to say, when the film of air is squeezed out. On reducing the pressure (with carbon at least), the resistance of the contact increases. Again, the resistance of the contact diminishes with increased current, an effect also noticed in the voltaic arc. Further, Mr. Bidwell finds that "when the strength of current exceeds a certain limit the resistance is greatly and permanently increased; the greater the pressure the higher will be such limit." This unexpected effect is difficult to explain on any theory but that of the "air discharge."

In the discussion which followed the reading of Mr. Munro's papers,

Prof. HUGHES said that he did not agree with Mr. Munro's theory of the air acting as a conductor, since very large currents pass through the microphonic contacts, showing that the resistance is much less than that of air.

Mr. PREECE considered the whole action of microphones to be due to heat. This theory is borne out by the fact that microphones are reversible—*i.e.*, they can act as receivers. The fact that the best microphonic effects are produced with a low electromotive force is against the air-discharge theory.

Mr. STROH* referred to an experiment which he had made to determine whether any movement took place in a microphone when a current was passed through it; in this experiment the movements of the carbon piece were magnified by a ray of light in disc reflected from a mirror attached to the carbon; no movement could be perceived when undulations were sent from a carbon transmitter, but makes-and-breaks of contact were distinctly seen.

Prof. AYRTON considered that the microphonic effect was due to a change of electromotive force, and not of resistance, at the points of contact.

Prof. ADAMS, Mr. WARWICK, and Dr. COFFIN also took part in the discussion.

The meeting then adjourned.

## Physical Society.—MARCH 10.

Professor G. C. FOSTER in the chair.

New Member—Major W. S. Boileau.

Mr. SHELFORD BIDWELL read a paper on "A New Method of Measuring Resistances with Constant Currents." It consists in placing a resistance-box in the arm of the bridge, which afterwards has to contain the unknown resistance. A balance is effected by unplugging resistance in this box. The unknown resistance is then inserted in the same arm and the balance restored by plugging resistance out of the box. The amount plugged out equals the unknown resistance. An abstract of this paper will be found in our other columns.

Prof. F. GUTHRIE made a communication on "Liquid Slabs." Films of liquid spread out like a flattened drop on a solid surface are found by the author to have a thickness which is a physical constant for the same liquid, provided the area is very great in proportion to the thickness. Sodium amalgam inserted in a mercury slab causes it to spread out further. Prof. Guthrie also finds that an electric current increases the diffusion of sodium amalgam through mercury in the direction of the current. Mr. BAILY suggested that as the diffusion produces a current, an opposing current might be found to stop the diffusion. Mr. STANLEY said the largest water drop he had measured was $\frac{1}{8}$th inch.

* See page 221.

## REVIEWS.

*Electro-Motors: A Treatise on the Means and Apparatus employed in the Transmission of Electrical Energy, and its conversion into Motive Power; for the use of Engineers and others.* By J. W. URQUHART. Manchester: W. T. Emmott, Blackfriars Street. London: Trübner and Co., Ludgate Hill.

THE information given by Mr. Urquhart in his latest work is, on the whole, of a useful nature, though, on the one hand, it is too elementary, and on the other not sufficiently explanatory to be of very general use. It is certainly a most difficult matter to produce a work of the kind which would be entirely satisfactory, and therefore we think that a criticism of it should not be severe. The work commences with a short historical sketch of the subject, and here Mr. Urquhart is somewhat unfortunate in his statements, for he says, "About the year 1834, a Russian philosopher, Professor Jacobi . . . succeeded in constructing an engine, the motive power of which was derived from an electric current, maintained by one of the first forms of voltaic battery. This machine was probably the *first* electro-motor ever constructed." On the next page, however, it is stated that an electro-motor . . . "in the form of a locomotive was tried by Mr. Davidson on the Edinburgh and Glasgow Railway, in 1832." The following chapters deal with "The Dynamical Nature of Electric Currents," "Electrical Measurements," "Electro-Magnetic Force," "Electro-Magnets and Armatures," "Electric Accumulators and Magazines," "The Construction and Efficiency of Electromotive Machines," "Electric Railways," "Minor Applications of Electromotive Energy," and "Fragmentary Information."

*Elements of Construction for Electro-magnets.* By Count TH. DU MONCEL. Translated from the French by C. J. Wharton. London: E. and F. N. Spon, Charing Cross.

WE noticed a short time ago the French edition of this work, and therefore further criticism is unnecessary. Mr. Wharton has certainly done great service by translating the book, and he has done his work thoroughly well. The fact of the publication being undertaken by Messrs. Spon is a sufficient guarantee of the "get up" of the volume.

WE have also received:—

*Report of the Chief Officer on the Metropolitan Fire Brigade.* It would have been interesting if this report had made some reference to the use of the electric fire-alarm signals, with remarks on their utility; no mention is, however, made of them. *Journal of the Society of Telegraph Engineers and of Electricians*, No. 45. *Réforme Médicale sous le Double Rapport Scientifique et Pratique*, by Dr. A. Bastings. Paris: Librarie J. B. Baillière et Fils, 19, Rue Hautefeuille; a book dealing largely with medical treatment by electricity.

**Experimental Confirmation of a Phenomenon predicted theoretically concerning the Distribution of the Galvanic Current in Conductors.**—G. Poloni.—The author demonstrates Volterra's proposition that when a current, *c*, is passed by means of two points of entrance, A and B, into a body in which the conductibility varies continuously from point to point, so there exists at the points, C and D, a given potential difference, the same potential difference appears between A and C, on passing the current between C and D. For this purpose the author uses a sheet of tin-foil, cut in various forms, and a broad parallelopipedal box of copper through which is passed a copper spiral; the current of a battery is passed through two points, A and B, by means of applied electrodes of rounded copper wire, and two other joints, C and D, are connected with a mirror-galvanometer the deviations of which are proportional to the potential difference in C and D. Then A and B are exchanged with C and D. The results agree with theory in many modifications of the position of the four points.—*Wiedemann's Beiblätter.*

### TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

Letters respecting Advertisements, Subscriptions, &c., should be sent to the "Publisher," ELECTRICAL REVIEW, at above address.

### SUBSCRIPTION RATES.

THE ELECTRICAL REVIEW can be had, by order, from any newsagent in town or country; or it can be supplied direct from the office on the following terms (payable in advance):—

| | |
|---|---|
| Half-yearly (postage included) ... ... | 9s. 9d. |
| Yearly ,, ,, ... ... | 19s. 6d. |

### FOREIGN SUBSCRIPTION RATES.

To all foreign countries (except those mentioned below):—

| | |
|---|---|
| Half-yearly (postage included) ... ... | 10s. 10d. |
| Yearly ,, ,, ... ... | 21s. 8d. |

*Exceptions*:—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia *viâ* Brindisi, Philippine Islands, Singapore, Zanzibar, to which places the rates are:—

| | |
|---|---|
| Half-yearly (postage included) ... ... | 11s. 11d. |
| Yearly ,, ,, ... ... | 23s. 10d. |

Vol. XI., handsomely bound, in cloth, gilt, now ready. Vols. 1, 2, 5, 6, 7, 8, 9, 10, can likewise be had.

A few complete sets also may yet be obtained. Prices on application to the Publisher.

Cloth cases for binding THE ELECTRICAL REVIEW supplied.

### ADVERTISEMENTS.

The rates for Advertisements may be obtained on application to the Publisher, ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C. Cheques and Post-office Orders (on Chief Office, London) to be made payable to H. ALABASTER.


## CORRESPONDENCE.

### Electric Light Conductors.

I observe that all your correspondents on this subject are agreed that for conductors of circular section the current they will safely bear varies as the diameter to the power of $\frac{3}{2}$; that is to say, that at any rate for this form of conductor my expression—

$$c \propto \sqrt{p\,a}$$

holds good. I have no doubt that it is equally true for other forms, and should like to see it generally recognised that a conductor of circular cross section will, *cæteris paribus*, heat more than one of any other form on account of the small amount of surface it exposes.

Mr. Ormiston's formula in your last issue agrees perfectly with mine, except that he legislates for a rise of temperature of 30° Fahr. only, while I allowed one of 40°.

His formula is—

$$c = \sqrt{\left(\frac{d}{\cdot 01286}\right)^3}$$

or roughly $$c = 685\, d^{\frac{3}{2}}$$

Mine is—

$$c = 500\, \sqrt{p\,a}$$

which for a circular section becomes roughly—

$$c = 785\, d^{\frac{3}{2}}$$

Now the rise of temperature in any given wire varies as the square of the current. Therefore, a wire taking Mr. Ormiston's current would be heated as compared with a wire taking my current, roughly as 3 : 4, or if his current raised the wire 30° mine would raise it 40°, which is not excessive for an electric light cable. Indeed, Mr. Ormiston himself shows that an ordinary cable stood a rise of 142·65°.

I must say I think my formula easier to remember than his, but am very glad to have got such a confirmation of the truth of it, and also that apparently it is not affected by a greater or less thickness of dielectric, provided the cable is everywhere freely exposed.

**P. C.**

I must apologise for inaccuracy in my letter on the Lighting Act, which was written very hastily without revision. "A variation of from 90 to 100 volts would mean a variation of power of from 100 to 150" should be "from 90 to 110 volts," &c. The high resistance Edison lamps would want 140 volts, not 240. The conductors of $3\frac{1}{2}$ inches diameter tapering uniformly would only absorb five per cent. of the power. Conductors $2\frac{1}{2}$ inches would absorb ten per cent., but would have a difference of potential of twenty per cent. The conductors should, then, be just under $2\frac{1}{2}$ inches at the thick ends, but should not taper uniformly, being comparatively thick at the far ends, to avoid fall of potential. Even then two and a half inches is an inconvenient diameter for leads. Of course the size might be lessened by making the dynamo give less E. M. F. with less current, and by other devices, but its own variation would cause trouble.

**Jas. Swinburne.**

### Telephonic Utility.

Having been asked the following question by a friend—Whether, while in Germany, or otherwise foreign, he bought a pair of telephones to use, for convenience, between his coach-house and library, or between his private office and manager's room, he could use the same without being intimidated by imaginative telephone monopolists, or, as was innocently remarked, compelled to pay an annual royalty? A general opinion would be esteemed, and, besides, prove useful.

**H. R. J.**

[Any articles patented in the United Kingdom, but manufactured abroad in a country where the article is not patented, cannot be introduced into this country, or worked in the latter, either for private or public purposes, without a royalty being paid to the owner or owners of the patent. Such an article, if brought from abroad, is liable to be seized at the Custom House.—EDS. ELEC. REV.]

### Pronunciation of "Dynamo."

When doctors differ we must fall back on principles. If your correspondent will turn up his Greek dictionary at the word "dynamai" and its cognates "dȳnāmis," "dynāmōō," and "dȳnātos," he will find *short* "y" and *short* "a" quite sufficient reason to reject the big un-classical mouthful "*dȳnahmo*" and to pronounce dȳn'āmo (= dinnāmo).

**W.**

### The Industrial Unit of Electrical Energy.

In reply to Mr. Swinburne's letter, had I more time I would answer him more in detail. He remarks that the unit of electric energy, which, as he *naïvely* puts it, I intend to write about, is the volt-coulomb or vomb. I would ask him why is it a volt-coulomb or a vomb? and who stood sponsor for the bantling? I am afraid that the vomb, if it simply expresses (as Mr. Swinburne says it does) merely the rate of flow, is an unnecessary complication calculated to be a snare and a delusion; while the Davy expresses the work done and not the rate of flow; hence it is a dynamic unit perfectly intelligible, as we have only to deal with the total resistance in circuit and multiply the same by the quotient of $\frac{HD^2}{T^2}$ a perfectly easy and simple calculation.

What we want is more unity and less units.

Coulomb doubtless rendered valuable assistance to electrical science and research, but is more identified with electro-statics; and according to my view of the matter, it causes confusion to associate his name with electro-dynamics.

Sir Humphrey Davy, who may be regarded as the father of Faraday, and who was the discoverer of the electric arc light, also the electro deposition of metals, &c., has not received the recognition to which he is entitled; on these grounds the HD is more appropriate and preferable; anyhow, I am willing to stake my Davy and allow Mr. Swinburne to vom(b) it as much as he pleases; and after he has recovered from the trying ordeal, should we ever meet in the flesh, if he is a generous individual, which I have every reason to believe him to be, we shall be both hale fellows well met.

**Fredk. H. Varley.**

Mildmay Park Works, N.,
*March 12th*, 1883.

## ELECTRIC LIGHTING AND LOCOMOTION.

(Lecture II., delivered by Professor AYRTON, F.R.S., at the London Institution, March 15th, 1883.)

IN my last lecture, I explained why small current combined with great electric pressure or high potential must necessarily be used for economy in electric transmission of power, and why, therefore, the series working of lamps and motors was better than the parallel system. I went pretty fully into the consideration of what was necessary to obtain safety, and we found experimentally that two conditions were essential: the first, that both the going and the return wires should be well insulated from one another as well as from the earth; the second, that the current should be absolutely constant in its strength, and not merely have the mean constancy obtainable with many of the so-called constant current dynamos.

The very important problem of supplying constant electric pressure to the mains, however many lamps or motors were being fed by them in parallel, was next considered, as well as the problem of supplying constant current to motors or lamps in series, however many lamps or motors were being worked in one circuit.

We ended by considering the great importance of driving quick moving tools like drills, fans, circular saws, &c., *directly* with electro-motors without intermediate gearing, because with such arrangement we saved first the loss of power that occurs in the shafting of a factory; secondly, the loss of power at the intermediate gearing employed to make the drill, or other quick moving tool, revolve much more rapidly than the shaft, and, lastly, we secured the great convenience of being able to bring the machine-driven tool to the work instead of, as at present, the work to the tool. And there is one case where the driving of fans by electro-motors appears to me to be at the present moment of vital importance to us as citizens of London, I might almost say of national importance to us as Englishmen. For years past we have gone on breathing the foul air in the underground railway. Much grumbling has been the result, but hitherto no ventilation, and at the present moment we are contemplating, as a sort of final resource, the possibility of unsightly openings being made in the roadway of the Embankment to let out the obnoxious gases. Now why do we not put fans at suitable intervals along the tunnel attached to quite small pipes for extracting the bad air? The fans could not, of course, be driven by steam-engines (there are steam-engines enough in the tunnel already), nor could they easily be driven by shafting or belting, but an electro-motor attached *directly* to each fan would furnish the driving-power without introducing any inconvenience whatever. No gearing would be necessary, a single insulated going and return wire would convey from motor to motor the electric power produced by a large dynamo outside the tunnel, and a steam-engine might puff away in some back yard, out of everybody's way, and give us perfect ventilation on the underground railway.

And when on the subject of electro-motors, I explained that Professor Perry and myself had been led to construct electro-motors on a different principle from that usually adopted. In a dynamo machine there are two electro-magnets, and the machine acts as a producer of electricity because the work that is necessary to be done to move one of the magnets relatively to the other to overcome their attractions and repulsions is turned into electric energy. In practice one of these electro-magnets is usually kept at rest, while the other is in motion. In one of them the current always flows in the same direction, while in the latter it is constantly being reversed in direction. The former is called the "field" or inducing magnet, while the latter is the "armature." Now it can be shown that in every dynamo-machine the magnetism produced by the current flowing round the armature must necessarily weaken the magnetism produced by the current flowing round the field-magnets, and hence must necessarily diminish the power of the dynamo.

Hence the best dynamos have been so designed that while the exciting electro-magnets form a very strong magnet the armature only produces a very weak one. This result has been arrived at partly by making the armature of a dynamo small, compared with the field electro-magnets, and partly by giving it a squat form; and because the field-magnet is large it is, as a rule, kept stationary, while the armature revolves inside its poles.

I went on to explain to you that Professor Perry and myself had concluded from certain theoretical and practical considerations that in an electro-motor, on the contrary, the strengths of the two magnetic fields produced respectively by the field-magnet and by the armature should be equal, since the one, so far from weakening the other, can be made to strengthen the other, and since the armature from its shape is necessarily rather a weak magnet, whereas the field, or exciting magnet, from its shape is a strong one, that we had reversed the usual condition of things and made the armature large and the field-magnet small, and that from this we had been led to make the armature stationary and surrounding the field-magnet, instead of, as is usual, the field-magnet surrounding the armature.

Our small field-magnet, then, carries the brushes and revolves inside the stationary armature, the coils of which are joined to the stationary commutator, c c, fig. 1, which, unlike ordinary commutators, we make flat to save both space and expense.

Wherever the brushes, B, happen to be at any particular moment, there two opposite magnetic poles are produced on the armature, as shown in fig. 1. As the brushes run

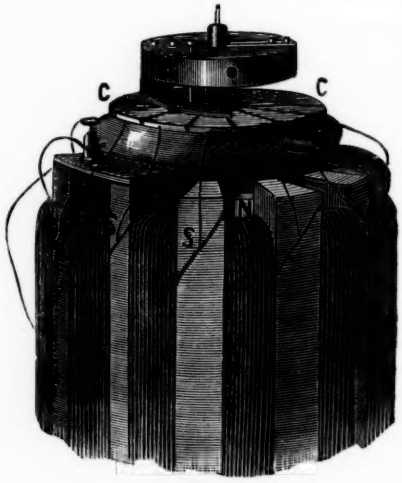



FIG. 1.

round and round so do these poles, and the brushes which, be it remembered, are carried by the field-magnet, are so set that the magnetic poles in the armature are always a little way in front of those in the field-magnet. The latter, therefore, are perpetually running after the former, but never catching them.

The law connecting the power of electro-motors with their size I dwelt on, and I explained that if the length, breadth and height of a motor be doubled so that its weight and cost becomes eight times as great as before, its power is about 20 times as great as before, and its efficiency or the ratio of useful power given out to electric power put in is also much increased.

I ended my lecture by referring, but from want of time only very briefly, to the governing of motors. An ordinary ungoverned motor goes very much faster when running empty than when there is a load on, but in practice it would never do for a piece of wood or iron in a lathe to rush round when the chisel was taken off, since not only would there be a great waste of power, but on next applying the chisel it would be probably broken by the wood or iron when rotating with such an excessive velocity. Not only, then, must we arrange in the way I described, that the supply of electric power is proportional to the demand, but also that the motors consume this power in proportion to the work they have to do; in other words, the electro-motor must be governed so as always to run at the same speed, whatever amount of work it may happen to be doing. I referred to the oldest form of governor for motors, which I have called the "spasmodic governor," and which I will now show in action. [Experiment shown and full explanation given.] The great objection to it is that it either supplies full power when the

motor is running too slowly, or no power when it is running too quickly, and therefore cannot produce a constant speed. Our "periodic governor," which never supplies full power or no power, but always an amount of power exactly in proportion to the demand, I very briefly referred to, and which I will now describe to you more in detail [Ayrton and Perry's "periodic governor" shown in action and fully explained*]; and lastly I referred to the most advanced system of governing motors, which we had arrived at by winding the motor with two distinct circuits in such a way that the current passing through one of them magnetises the iron, causes the machine to act as a motor, and consequently is itself resisted, whereas the current passing through the other circuit tends to demagnetise the iron and stop the motion, and consequently is itself helped on; in fact we have combined a motor and a dynamo in one machine, and so have dispensed altogether

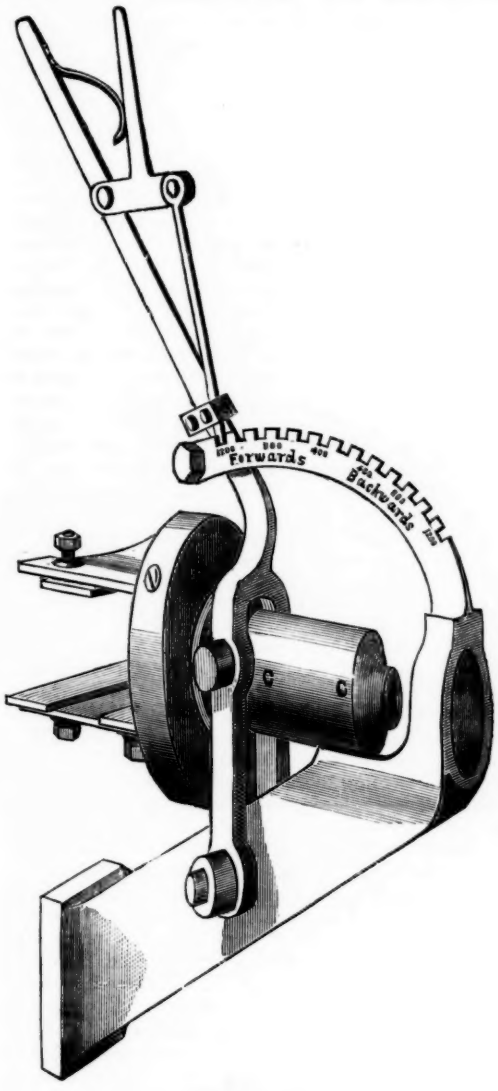


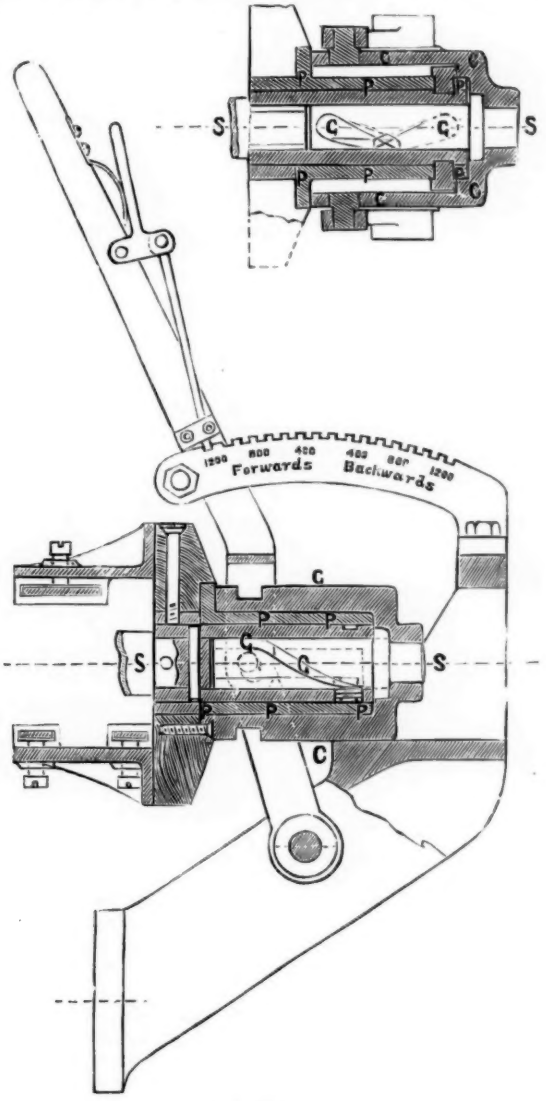

FIG. 2.

with anything of the nature of a mechanical governor. In the spasmodic, as well as in our periodic governor, the regulating action is produced by the supply of power being cut off when the motor is beginning to go too fast, but in our combined motor it is usefully employed to reproduce electric energy, which is added to the supply in the main circuit. In the one case, when less work has to be done by the motor, less electric power is given it, while with our combined motor the supply always remains the same, but when much work has to be done by the motor, nearly all the electric supply is turned into useful mechanical work; whereas, on the other hand, when little useful work has to be done, a portion of the supply, after being turned into kinetic energy, is re-converted into electric energy, and added to the supply

* *See* page 164, ELECTRICAL REVIEW, Feb. 24, 1883.

going to other motors. The difference in principle is of this nature—the periodic governor corresponds with a man who, when he has not much work to do, does not eat much, lives economically, in fact, whereas our combined motor corresponds with a man who always eats the same amount every day, but when he has little work to do on his own account, immediately goes and helps somebody else who is hard pressed with work. [Experiments were then shown with the combined motor, and it was proved that the change of load which diminished the speed of the ungoverned motor from 1,560 revolutions per minute to 508, only reduced the speed in one of Ayrton and Perry's governed motors of the same size from 1,250 to 1,184 revolutions per minute.]

But we find that it is not even necessary to wind the motor with two distinct circuits in order to obtain a certain amount of governing, and this arises from the fact that our




FIGS. 3, 4.

machine will act as a motor without any winding at all on the revolving field-magnets. Here is an example of such an unwound motor. I pass a current through it and it at once commences to revolve, and, as you see, revolves rapidly. [Experiment shown.] This arises from the fact that the magnetism in the stationary armature induces opposite magnetism in the iron of the field-magnets, and the brushes are so placed that the magnetic poles in the armature are always just in front of those in the iron, which latter are always running round and round after those in the former, but never catch them up.

In some of the early electro-motors pieces of soft iron moved in the neighbourhood of stationary electro-magnets, but in that case the continuous motion of the iron was maintained in a totally different way from that employed in

our unwound motors, because in those older motors a piece of iron was pulled towards a stationary electro-magnet, opposite which it would have stopped, but that just as it was approaching the end of the electro-magnet the current was stopped and the iron went on by its own momentum; the pulls were therefore intermittent and not continuous, as in the case of our unwound motor.

Now, suppose we have one of our motors adjusted to run without any winding on the field-magnets, and imagine we wind the field-magnets in such a direction that the motor would tend to turn in the opposite direction when a current passed round the coil wound round the field-magnets, what would happen? Why, if the magnetism induced in the field-magnets by the current flowing round it were stronger than the opposite magnetism induced in the iron by the armature, we should have the very curious and novel result that the direction of the motor could be reversed by simply short-circuiting, with a thick piece of wire, the current flowing round the field-magnets, and this result we have practically attained, as I will now show you. [Experiment shown.] Allow the current to flow through the armature and field-magnets and the motor runs one way; let it only flow through the armature alone and the motion is instantaneously reversed. Merely pressing down the key then reverses the motion. Hitherto the much more complicated arrangement of reversing the electric connections between the armature and field-magnet had always been thought necessary to reverse the direction of motion of a motor.

We have in the preceding considered that the magnetism produced by the coil on the field-magnets was greater than that produced by the induction of the armature itself, and so determined the direction of motion. But suppose that is not the case, then what will happen? Why, in that case the current passing through the coil on the field-magnets will be resisting the motion, and so will be helped on. But that, as we saw before, is exactly the condition necessary for governing. The armature then and the iron of the field-magnets act as a motor, while the armature and the coil wound round it act as a dynamo, and if the resistance of the coil, which we make of fine wire, and as a shunt to the armature, is of proper resistance so that the required speed the motor is to run at is the critical speed of the dynamo, the governing of our motor may be made fairly perfect with only one circuit on it.

Hitherto we have been dealing with motors especially intended always to run at one speed whatever amount of work they might be doing. We next come to motors for electric tramcars, tricycles, &c., designed to run at any desired speed forwards or backwards.

I have spoken about the set of the brushes relatively to the field-magnet, and the set, or "lead" as it is technically called, is of great practical importance, since on the amount of lead depends which way the motor revolves, or whether it revolves at all. Although the fact that the direction of rotation could be reversed by a sufficient change in the lead was well known, the importance of varying the lead in motors for different speeds appears to be little attended to, since it is impossible as a rule in motors, from their construction, to make small changes in the lead. In our motors, on the other hand, the flat brush-holder can be revolved forwards or backwards by hand through any angle, so that any lead forwards or backwards can be given to the brushes for each speed, and in our larger motors, of which I have a sample here, the lead can be made anything we like simply by moving a handle, such as a locomotive engine-driver is accustomed to use for acting on the link-motion of his engine. Push the handle shown in figs. 2, 3, and 4 forwards, and the motor revolves rapidly in one direction; pull it backwards, and it revolves as rapidly in the other direction. Push it not so far forwards, and it does not revolve so fast in the first direction; pull it not so far backwards, and it does not revolve so fast backwards. In fact, by moving the handle forwards or backwards any speed, in either direction, is obtainable. The action of our "lead adjuster" is as follows:—Attached to the rotating field-magnet is the spindle, S S, which is itself attached to, and rotates with, the outer collar, C C. On pushing the handle forwards or backwards this collar is moved along the spindle, and the effect of this is to cause a pin to move along the groove, G G, and so cause the inner collar, P P, which usually rotates along with C C and the field-magnet, to move a little forwards or backwards relatively to C C. Now it is the collar, P P, which is screwed to the brush holder, hence we are able, even when the motor is running, to shift the brushes relatively to the field-magnet together with which they are rotating, and consequently with only *one pair* of brushes to give any lead forwards or backwards we desire. In other cases we alter the lead by means of a wheel and screw, and so get very easily a very accurate adjustment. A table of speeds can be engraved, showing the position the handle should be in for 500 revolutions a minute, or 700 revolutions a minute, &c.

On the last occasion I showed you photographs of all the principal electric railways, and we saw that in some cases the current went by an auxiliary insulated rail, passed through the motor under the train, and came back by the rails. In other cases both the going and return wires were of the nature of stout overhead telegraph wires, and a running connection between the motor on the tramcar and these wires was kept up by two small jockeys, that were pulled along the telegraph wires by wires attached to the tramcar. In a third system, the going and return conductors were simply ordinary rails on which the train runs, the insulation produced by the rails merely resting on wooden sleepers, having been found sufficient for a length of one or two miles. As you will see from the photographs that I now project on the screen, this last and simplest plan has been adopted for the Portrush Railway, near the Giant's Causeway, in Ireland. This electric railway, Mr. Traill (the chairman) has been so good as to write to me, "runs on a footpath, or trampath, by the side of the road, which has been widened for the purpose from 24 to 27 feet. The path is 7 feet wide, leaving 20 for the carriage-way. We first tried," he says, "sending the current by one rail, returning by the other rail, after passing across by the car, and for this purpose had laid the rails in asphalte with thick felt underneath, but we found that the leakage, especially in wet weather, was too great to justify us in continuing that kind of insulation for six miles." Now this is exactly the result I predicted in my lectures on electric railways delivered last year, and in order to make the difficulty quite clear to you, I will show you the experiment I then showed to prove this. A portion of the going wire conveying the current working that motor driving the circular saw is, as you observe, wrapped round this bit of wood, and a portion of the return wire round this other piece of wood. As the two pieces of wood are dry there is very little leakage from the wire on the one to the wire on the other, although the wire wrapped round each is bare. If, however, without allowing these pieces of wood to touch one another, I immerse the ends of them in this vessel of water I shall produce the same effect as if a shower of rain fell at one end of the electric railway. Now, observe what happens, the motor immediately begins to go more slowly. Let me immerse them further, which will correspond with the rain becoming more general over the line, and the motor goes still more slowly, and now the motor stops altogether, so much of the current, in fact, leaking from the going to the return wire through the water that sufficient does not pass through the distant electro-motor to keep up its motion.

How then has this difficulty been overcome at the Giant's Causeway? Mr. Traill's letter tells us. He says, "We have therefore placed a third rail of iron on wooden props close into the fence, so that a brush sticking out from the car on a steel bar runs along the top of this third rail, which is about 15 inches from the ground." He goes on to say that this third rail is embedded in tar on the tops of the posts, and that when in addition pieces of the new insulating material, "insulite," are introduced between the rail and the wooden posts they expect the insulation will be perfect. He adds, "At present we can run for over two miles on the road up and down hill gradients as great as 1 in 35. We took six tons up that incline the other day. We are about to erect turbines at the Waterfall above Bushmills, which will give us from 60 to 100 horse-power, and will generate the current there about half a mile from our main line at Bushmills. We have powers by our Act of Parliament to construct a railway from Bushmills to Dervock, inland about seven miles, almost at right angles to the line of tramway on the sea coast. As the waterfall is near the junction of railway and tramway we intend to use it for the railway as well, as the works will do for both. We are limited by an Act to 10 miles an hour on the tramway, but will have no difficulty in going to 20 or 25 miles an hour on the railway, which has also the advantage of being level the entire way."

But although they have succeeded at Portrush in over-

coming the difficulty of leakage by using this third insulated rail, resting on posts 15 inches above the ground, such a system presents, you will easily see, great inconveniences for ordinary railways, since at every crossing there would be this raised rail in the way of the trains, and an even greater objection is the risk that it introduces, that any one can, from carelessness or malice, by resting, say, a crowbar against this raised insulated rail, send all the electricity to the earth and so cut off all electric power from all the trains either in front or behind.

On the other hand, the plan of using stout telegraph wires, with running jockeys to keep up continuous electric connection between these wires and the moving train, would present great mechanical difficulties if the trains were going at 60 miles an hour.

What, then, do we propose? Professor Perry's and my plan is shown in the pictures in your hands, and is this: we electrically subdivide the rubbed rail into a number of

ECONOMIC ELECTRIC TRANSMISSION OF POWER FROM AN ENGINE IN THE COUNTRY BY USING ACCUMULATORS COMBINED WITH LAMPS AND MOTORS IN VARIOUS PARTS OF THE TOWN.

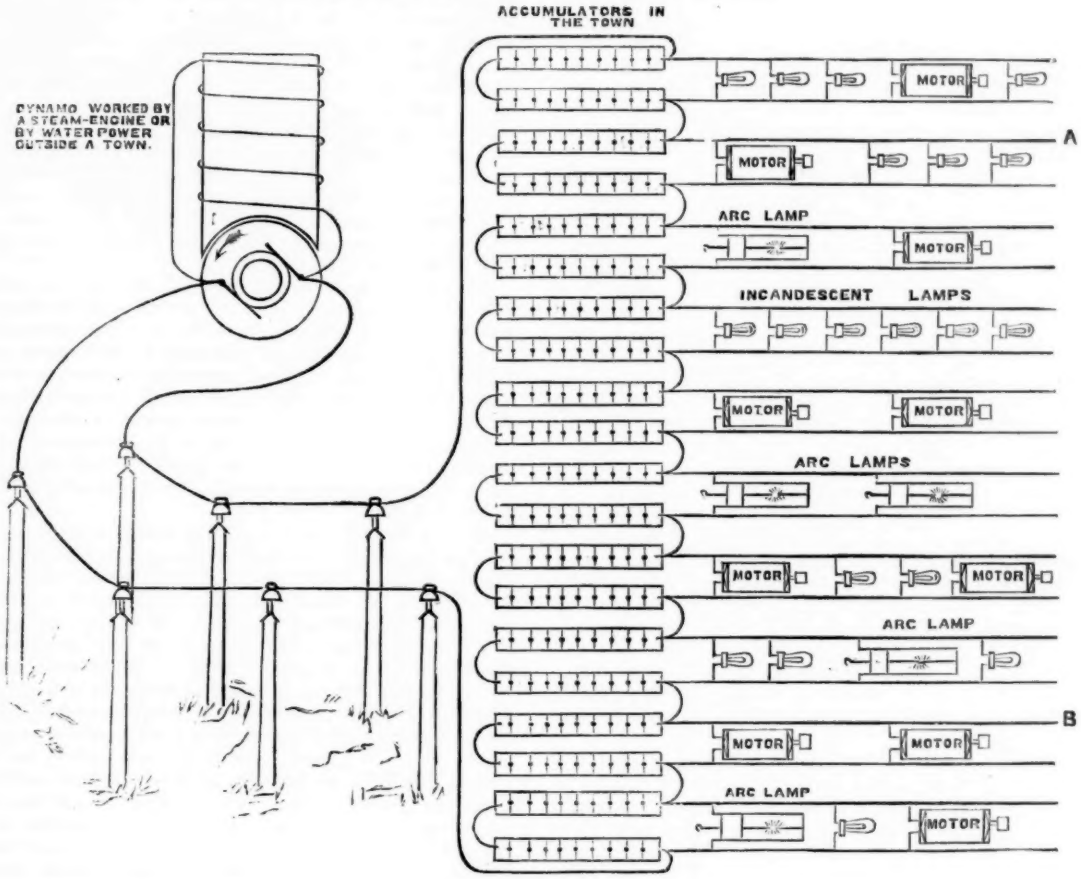



FIG. 5.

sections all fairly, but by no means perfectly, insulated from the ground. We do not apply our electricity directly to this rubbed rail, but, instead, to a well-insulated conductor, which may be buried underground or may be insulated by resting like a telegraph line on insulators on posts, and we arrange that whenever a train enters on to any section, it automatically makes an electric connection between that section of the rubbed rail and the well-insulated conductor which supplies the power, and at the same time automatically cuts off the electric power from the section the train has just left, and in this way we confine the leakage of electricity to that section on which the train is at any particular time, and so reduce the leakage and waste of power on the longest electric railway to less than it is at present on the shortest line constructed on the Berlin plan.

But not only does a train on entering any section automatically turn on the electric power to that section, and cut it off from the one just left, but it accomplishes something more; it blocks absolutely the section just left. Let us take an example:—Suppose a train is passing from section A to section B, then not only is the power automatically turned on to section B and cut off from section A, but no following train entering on section A can receive power and move on as long as the train in front is on section B. It is not until the preceding train has passed into section C that the following train can proceed along section A. And, in addition, whenever a train is approaching too near a train in front, and in consequence finds itself deprived of driving-power, it is by a special plan we have contrived automatically, powerfully braked.

Whenever, then, a train—it may be even a runaway engine—enters on a blocked section, not only is all motive power withdrawn from it, but it is in addition automatically powerfully braked quite independent of the action of signalman, guard, or engine-driver, even if either the latter two men be present, which, bear in mind, is not at all necessary with our electric railway. No fog nor colour blindness, nor different codes of signals on different lines, nor mistakes arising from the exhausted, nervous condition of overworked signalmen can with our system produce a collision. The English system of blocking means merely giving an order to stop, but whether this is understood or intelligently carried out is only settled by the happening or non-happening of a subsequent collision. Our absolute automatic block acts as if the steam were automatically shut off, and the brake put on whenever the train is running into danger; nay, it does more than this, it acts as if the fires were put out, and all the coal taken away, since it is quite out of the power of the engine-driver, if there be one, to re-start the train until the one in front is at a safe distance ahead.

At present much household work is done by hand, simply because there are no easily-worked machines for doing it. The old knife-board has given way to the rotary knife-cleaner, but even that requires a certain amount of grinding to give the knives a polish, so that for large establishments a knife-cleaner boy is still necessary. The blacking of boots, the blacking of grates, the cleaning of doorsteps, &c., are all done in a most laborious way by hand. (I might almost say the operation seems not to be confined to hand, judging from the generally smutty appearance of Sarah Anne after

the process.) Now, there can be no doubt that very shortly electricity will be supplied, as gas is now supplied, to houses for lighting purposes, and when this has been accomplished, the same wires that convey the electricity for lighting, can in the day convey the power to work electric motors to turn rotary knife-cleaners, to turn a wheel for the blacking of boots, and a small motor carrying a brush like the one in my hand will simply be passed by the servant all over the grate for the purpose of giving it a good black polish. The black-lead brush will then be taken off, and replaced by the blacking brush for the boots, and later on in the day a rotary flannel will officiate for the door-steps.

The high price of land in towns necessitates gas-works being in the suburbs, so in the future the electric works must be in the country, and probably farther away from the towns than even gas-works are at the present time, because not only will great economy be so attainable, but the town will be freed from the smoke of the engines to drive the dynamo machines or producers of electric current, and by that time we shall have begun to realise that a smoky atmosphere is a poisonous atmosphere; further, if our dynamos are far away in the country advantage can also be taken of natural sources of water-power.

The transmission, then, of power by electricity is not only a problem which must be solved, but is one which calls for immediate solution.

For the economic electric transport of power we must produce, as I have explained, a great difference of potentials by a dynamo at the place where the power is obtainable—in the suburbs where, for example, is the steam-engine or water-wheel—and employ some mechanism which can be worked by this great difference of potentials at the place where the power is to be utilised—that is, in the town. There is no difficulty in arranging a dynamo wound with fine wire, or a set of dynamos in series with one another, to produce any difference of potentials required; but there is a far greater difficulty in using this great difference of potentials at the town end of the line. If lamps and motors of the present construction are used they would have to be put in series, but in that case if the current is stopped passing through one it will be stopped passing through all. This difficulty can to a great extent be avoided by using "cut-outs," as I described to you in my last lecture. At the same time nobody would be perfectly satisfied that his supply of electric power should depend on the good working of all the electric apparatus in the same street, much less that it should depend on the good working of all the electric apparatus in the same town. We are content that our supply of gas or water should depend on the good working of the gas or water-works, but we could not tolerate the possibility of Betsy Jane, in Moorgate Street, from some carelessness or other, being able to cut off our supply at the London Institution. That Jack Frost should stop our supply is bad enough, but Betsy Jane—no!

What, then, are we to do? High difference of potential we must use, and we cannot work the lamps and motors in parallel unless they have a resistance of tens of thousands of ohms, in fact, are of a totally different description from the lamps and motors of the present day. The solution was first suggested by Sir William Thomson in 1881, and, I am happy to say, will very shortly be carried out by Prof. Perry and myself in Paris, under the auspices of the French Electrical Storage Company. It is to use the small current and great difference of potentials to charge a very large number of accumulators, in series, in the town, and to discharge them in sets, as shown in the figure, each set supplying the energy for one street, or, possibly, for one district. Of course, the going and return wires between the dynamo and accumulators must be separately insulated, and put so far apart that there is no fear of a man or an animal accidentally touching both. If, in addition, it is feared that although this precaution is taken still somebody may touch a leading wire, say, A, coming from somewhere near one end of the accumulators, while another person may accidentally touch a leading-wire, B, coming from somewhere near the other end of the accumulators, and so both receive a fatal shock, this may be also entirely avoided by electrically disconnecting the various sets of accumulators from one another, and from the main charging wires coming from the dynamo before they are connected respectively to the local leads in the streets for being discharged.

Suppose a thousand accumulators were thus employed, and a charging current of 33 ampères were used. To balance the electromotive force of the accumulators about 2,100 volts would be required. If the resistance of each cell were 0·005 of an ohm during charging, then 165 volts difference of potentials would be required to send a current of 33 ampères through this resistance, or a total difference of potentials of 2,265 volts would have to be maintained at the terminals of the accumulators. Hence about 100 horse-power would be put into them.

The next question that arises is, what size of conducting wire is it proper to use to convey a current of 33 ampères? If the conductor is thin it will certainly not cost much to erect, but, on the other hand, the resistance to the passage of the current will be great, and much of the power will be wasted in the heating of the wire. On the contrary, if the conductor is very thick, there will be practically no waste of power by the heating of the wire, but the capital sunk in working it will be excessive. It is clear, then, that there is some thickness which gives us the best results, and Sir William Thomson has worked out this problem for us, and has shown us that the thickness of the conductor proper to be used for any particular current does not depend at all on the length of the conductor, but depends first on the strength of current passing through the conductor, second, on the cost of copper per ton, and third, on the market value of one horse-power supplied for a year. Assuming that good conductivity copper costs £70 per ton, and that the market value of a horse-power is £10 per annum, the proper diameter to give to a conductor conveying a current of 33 ampères, comes out to be 32-100ths of an inch, or a trifle over 3-10ths, on the assumption that the current passes for 12 hours out of every 24.

In order to send this 33 ampères through ten miles of going and ten miles of return copper wire, 32-100ths of an inch in diameter, as well as through the 1,000 accumulators, will necessitate the dynamo producing a difference of potentials of 2,654 volts. Under these circumstances calculation shows that about 17 horse-power would be lost in heating the line-wires, about seven horse-power in charging the accumulators, and about a further 25 horse-power in the dynamo itself, which is in the country. 142 horse-power must, therefore, be given by the steam-engine or water-wheel to this dynamo.

We come to the conclusion, then, that if 142 horse-power is given by the engine to the dynamo, 117 is given up by the dynamo to the wires; 100 is given up by the wires to the accumulators in the town, and 93 is stored up in the accumulators for future use, the total horse-power usefully stored up in the accumulators being in this particular case about 65 per cent. of that given to the dynamo by the engine.

The world thinks of a current of electricity as it thinks of a current of water. Now, there is this very essential difference between the supply of electricity to houses and the supply of gas or water to houses. When gas is supplied, you have only to deal with the *quantity* supplied; you are not going to use the pressure of the gas to do work, even if the gas is to be used in a gas-engine. It is only the burning of the gas that you are interested in. You are really dealing, therefore with *quantity* of gas. Similarly when water is supplied, nobody cares very much about the pressure so long as it is sufficiently high to reach the top storey of his house. But if the pressure is 700 lb. per square inch, as used by Sir William Armstrong, or 1,500 lb. per square inch, as used by Mr. Tweddell, then the pressure becomes a very serious matter. Ordinary water is mainly used for drinking and washing purposes, and although this high pressure of water could also be used for drinking and washing, nobody but a millionaire would think of such extravagance; for it is not merely water, but water at a pressure of 1,500 lb. per square inch that is supplied, and every cubic foot of water received per minute at that pressure by the consumer means 6 horse-power. In that case the pressure is all-important, and for measurement you must take the quantity of water multiplied by the pressure. And although mere quantity of water may be important for washing purposes, we know of no purpose requiring mere quantity of electricity; it is needed as a source of energy to drive a motor, or to produce light, and the *amount of energy*, not the *quantity of electricity*, is what must be measured.

In any proper commercial recording meter for electricity

a record must be kept, therefore, of two things, the quantity of electricity and the pressure which it is supplied at. Now, the electric meter or "Ergmeter," as we call it, designed by Prof. Perry and myself for this purpose, is hanging up here (fig. 6). It consists of a fairly good pendulum clock,

FIG. 6.

possessing a seconds hand. The pendulum bob has been taken off, and a coil of wire, P, of about 1,000 ohms resistance substituted in place of it. Fixed on the case of the clock, near the fine wire coil, there is a coil of thick wire, C, through which the main current passes. The course of the current is this. It enters the house at the binding-screw, B, passes through the coil of thick wire, C, comes out at the binding-screw, Q, and proceeds through all the electric lamps, motors, or other electric machinery in the house, and then passes away either to the electric main under the street or to another house. The binding-screw, B, is, as the figure shows, not only connected to one end of the thick wire coil, but is connected to one end of the fine wire coil of the pendulum which passes up the pendulum-rod. The other end of the fine wire coil which passes up the other side of the pendulum-rod is connected to the binding-screw, R, and R is connected by means of a fine wire to the electric house-main just where it leaves the house.

The current passing through the pendulum bob depends on the difference of electric pressure at the main where it enters the house and leaves the house, whereas the current passing through the thick wire coil, C, is the total current working the lamps and motors. Now, the electric power being supplied to the house depends on the strength of one of these currents multiplied by strength of the other, and it can be proved mathematically as well as, of course, experimentally that the total quantity of electric energy supplied to the house during any time, whether sometimes in the form of high pressure and small current, or sometimes in the form of small pressure and large current, is exactly proportional to the loss of the clock in that time. The number of minutes of slowness is the measure of electric energy supplied to the house, and is what should be charged for. An ordinary clock may doubtless lose a few minutes in a week, but we of course make the loss which we want to observe much greater than this. An ordinary clock wants winding up every week, but this of course is easily got over, and if experience in the future shows that the observations of the ergmeter by the electric inspector are only taken at such distant periods that the clock would lose more than twelve hours between his visits, due to its measuring the electric energy supplied to the house in that time, then a hand will be added which takes, if we like, a day to make one complete revolution.

In the legislation which has recently taken place in connection with the commercial supply of electricity, a mistaken notion has grown up that the *quantity* of electricity is what should be recorded, and not electric energy. Now, not only is this bad in that it prevents an estimate being easily formed of the relative prices charged by the different companies for the supply of electricity, since the different companies use normally very different electric pressure, but even the most perfect system of governing dynamos, such as I described to you last time, or of laying the wires under the streets, such as has been suggested by Mr. Edison, will not enable the electric pressure at any house to be kept absolutely constant during the evening, even if the electric pressure at the mains where they leave the dynamo is kept absolutely constant.

That is to say: With any system that has been hitherto suggested it is physically impossible, and therefore, I need hardly say, cannot be made possible by legislation, to keep the pressure at a considerable distance from the producing station absolutely independent of the number of intermediate houses that are consuming electric power. In our opinion, then, we should not tolerate either the recording of, or the paying for, the *quantity* of electricity supplied, but we must record and pay simply for, the total electric *energy* supplied.

Two years ago the storage of electric energy in black boxes, and their power taken out of them by Sir Wm. Thomson, may have passed before the minds of the public as one of those mere seven days' wonders which in these latter times have become so common. But to the scientific man, who could foresee the possibilities connected with the electrical storage of power, these experiments of Sir Wm. Thomson were of pre-eminent importance.

The two latest employments of electricity stored in Faure-Sellon-Volckmar accumulators are in the boat *Electricity*, which many may have seen running last Saturday at Kew, and a photograph of which I now project on the screen, and the electric tricycle of Prof. Perry and myself. In the tricycle no work is done by the rider, but little black boxes, carried on the base-board, contain the stored electric energy, pretty much in the same way as a horse's body contains its breakfast of oats and hay, with the difference that with the accumulator it is the receptacle which has weight, so that neither in receiving its feed in the morning or discharging its power during the day does the accumulator gain or lose in its weight. By means of a tap the rider can turn on more or less electricity and go faster or slower. The faster he is going the less is the waste of the electricity, although, of course, the consumption of power is greater than when going slowly—that is to say, the faster the tricycle goes the more efficient is the whole arrangement. On the other hand, when the electric supply tap is turned off, and the tricycle is at rest, the waste in the accumulators is not large, and the tricycle stands for days ready for immediate use without any waste analogous with an unused horse "eating his head off."

But although the electric tricycle ceases using up its last supply of electricity when it stops, and requires no feeding while motionless, still it must be fed periodically if used regularly. But very shortly I expect to see the tricyclist dismounting at his inn, with the sign, perhaps, of the "Faraday," having the certainty that in the morning he will find his accumulators fully charged up with the electric machine of the inn, also used for lighting and agricultural purposes. I feel also sure that when this is the case the charge in his bill for the electric feed will be one of the smallest items entered.

Let us now adjourn to the Library to see our electrically-lighted and driven tricycle in actual operation, and which the size of this lecture hall, large though it be, prevents my showing you here, and, that you may judge of the tricycle's power, I may mention that with it we have actually run a measured mile in $8\frac{3}{4}$ minutes, when the tricycle was carrying a man of average weight and the necessary supply of electric accumulators to propel it for about two hours.

What stored electricity can do, the accumulators before you, lent me by the kindness of the Electrical Power Storage Company, have shown. What the future of electric locomotion can be, who can say? the subject is yet young—very young. Improvements on what I have told you about to-night will doubtless be made; perhaps Professor Perry and myself already see how progress may be made; but, at all events, I trust I have shown you that electric locomotion is already so far developed as to be a real commercial subject of discussion.

## NOTES.

**Electric Lighting.**—On Friday night of last week, Principal Jamieson, F.R.S.E., College of Science and Art, Glasgow, gave a free public lecture under the auspices of the Mining Institute of Scotland, in the Choral Hall, Hamilton, on "Electric Lighting." There was a large audience. Many interesting practical experiments were made with various lights.

Sir William Thomson writes us from the Glasgow University under date March 12:—"I enclose an examination paper of which Questions 2 and 3 may interest your readers as having an application of considerable practical importance. They were set to illustrate the reason for the rule that the axis of a dynamo for electric lighting on board ship ought to be placed not athwart ship, but fore-and-aft. It seems, indeed, that this rule is not yet generally known to electrical engineers, as it has been violated (with detrimental results) in some of the largest of recent electric light installations on board ship." The following are the questions referred to:—(2). "A wheel oscillates about its axis according to the simple harmonic law through a range of 20° on each side of the mean position, in a period of 16 seconds. Prove that the maximum angular velocity of the wheel is approximately ·137 radian per second. (3). A dynamo machine is mounted in a ship with its axis of rotation in the thwart-ship direction. The mass of the rotating wheel is 100 kilogrammes, its radius of gyration 25 centimetres, and velocity of rotation 2,000 revolutions per minute; length of axis between bearings 60 centimetres. The ship rolls 20° on each side of the vertical in a period of 16 seconds. Required the maximum gyrostatic pressures of the bearings on the axis of the dynamo (use the answer to Question 2 in your calculation)."

Twelve of the Fyfe-Main arc lamps of three thousand actual candle-power, recently sent to Australia, have been selected to light the Houses of Parliament, Sydney, New South Wales.

A deputation of the Lighting Committee of the Leeds Corporation, consisting of about twelve members, visited the metropolis last week, and examined the different systems of electric lighting. They called at the *Daily Telegraph* offices, Fleet Street, where they spent some hours, and saw the practical application of the Fyfe-Main arc lamps in lighting the machine and folding-rooms during the printing of the paper. They expressed themselves highly satisfied with the suitability and steadiness of the light.

In our last issue we intimated that the executive of the International Fisheries Exhibition had decided to light the galleries by electricity. Messrs. Davey, Paxman and Co., the Standard Iron Works, Colchester, have been selected to supply the necessary steam-power, and are now preparing over 600 indicated horse-power of engines and boilers for the purpose. There will be four engines, one of which will indicate about 350 horse-power. The machinery is expected to be ready for the opening day, May 1st next.

The Great Western Electric Light and Power Company (Limited) held a meeting last week, at which special resolutions were submitted and unanimously adopted, authorising the directors to take the necessary steps to make the shares with £2 10s. paid fully paid-up shares.

Recently the *Neue Freie Presse* called attention to the experimental application of the electric light to the illumination of the largest infirmary at Vienna. Two wards, containing respectively 18 and 26 beds, the operating-room, and the medical instruction-room were lighted by Swan's system, the operating-room being lighted with four fixed lamps, and the wards by a fixed light each, as well as a portable lamp to be used for purposes where the close proximity of light is required. The journal in question remarks that the accumulator system in use obviated the necessity of the dynamo and machinery working at night, but that this method is too expensive for general purposes.

The Jablochkoff Electric Light Company has obtained permission from the Marylebone Vestry, London, to apply for a licence to light a large area of their parish.

It has been decided that the whole of the auditorium of the new Royal Lyceum Theatre, Edinburgh, shall be lighted by means of Swan's incandescent lamps. The dynamo machine is to be worked by one of Messrs. Crossley's gas-engines.

Another amusing incident was added on Thursday week to the many of which the New Law Courts have been the centre. About six o'clock, when the Lord Chief Justice was about to sum up, the electric light suddenly went out. His Lordship, after commenting upon the mysterious propensities of these scientific inventions, called for candles. It was subsequently found that the engineer in charge of the lights had been told that all the Courts had risen, and consequently he drew his fires. When he learned that the Lord Chief Justice was still sitting the fires were relighted, and, by the unstinted consumption of paper and wood, the engines were got to work again, and the Court was once more illuminated by the "scientific invention of mysterious propensity."

The following particulars of the work done, in hand, and expected by the Maxim-Weston Electric Light and Power Company are furnished by Mr. Hugh Watt, managing director to that company, to some of our financial contemporaries, with the view of correcting "false impressions in those who are not conversant with the press wire-pullers. The profits on sale of plant during the last month or two are far in excess of any previous period, and we are meeting with a ready sale for our lamps, although we are now turning out four times the number than when I joined the company, and at half the cost. Among the orders recently received or contracts closed, I may mention Buckingham Palace, Navy order, Government contract (and a further one pending), contract to light two large theatres and some surrounding establishments, a large number of establishments from our Pentonville centre, besides sale of several installations. We have also tendered for six of the largest installations yet attempted by any company for the lighting of about a score of steamers, mines, mills, and warehouses, and have already the promise of four out of eight steamers.

"The jealousy of certain rivals is hardly to be wondered at, in view of the fact that our lighting of Queen Victoria Street with Weston arcs, and Pentonville Road with Maxim lamps, far excel in brilliancy and steadiness anything accomplished till now in Europe——" (What a blow!!!)

An estimate, from the Brush Electric Light and Power Company of Scotland, for lighting certain streets in Broughty-Ferry, was submitted to the commissioners of that town at their meeting on Monday. The estimate provides for twelve Brush arc lamps, to burn on an average six hours per day, and the cost for one year is put down at 3¾d. per lamp per hour.

At the same meeting a letter was read from the Electric Carbon Storage and Manufacturing Company (Scotland) asking to be heard before anything is done. After deliberation, the commissioners agreed that it is now too late to take up the matter this year.

---

**Professor Forbes' Accumulator.**—The Electric Carbon Storage, &c., Company of Scotland states that it is now able to supply these accumulators. We read that they have been very thoroughly tested, and have given most excellent results. Whereas all other accumulators are of 2¼ volts electromotive force at most, these of Prof. Forbes give generally 2½, and can be made to give 2¾ volts in practice, thereby effecting, as is well known, not only considerable economy in first cost, but also in working. Thus, according to the company's circular, 100 *of Forbes' accumulators are equal to* 125 *of the ordinary kind in first cost, and again in working.* The economy in working occurs because that the potential of the cell being so much higher, and fewer cells therefore required, the total internal resistance of the battery is less and the current is forced across this lower resistance at greater head or pressure. The formation of sulphate of lead during repose, so great a drawback with the earlier accumulators, *sometimes rendering them useless, is not perceptible in Professor Forbes' accumulator,* even to careful observation. These accumulators, where installed by the company or its agents, will be guaranteed, and will be

generally guaranteed when they are to be used under the direction of a competent electrician. For incandescent electric lighting, the accumulators are made in two sizes respectively, to give light for five hours and for ten hours. The prices of the accumulators will be found on comparison to be lower than those of any other company, while, as shown, the practical results are much better. Small self-regulating machines for charging these accumulators can be obtained of the company (only).

The incandescent lamps manufactured by the company are extremely simple in construction, and have been found to give most economical results, and in light afforded will be found to be equal to any in the market; but the company is prepared to supply those of other makers if desired. These lamps are of sizes varying each from two candles to fifty candles, and are suitable for all purposes. When desired the company will supply an engineer to advise and assist in making detailed estimates. With regard to dynamo machines, those supplied by the company are the only self-regulating ones patented in Europe, and are far superior to any dynamo yet introduced.

**The Vienna International Electric Exhibition.**—Judging by the applications which have up till now been received, this exhibition promises in many respects to surpass any of its predecessors. Denmark, Spain, and Italy have within the last few days contributed to the list of exhibitors. Of the new comers we may mention, from Italy:—The Societa Anonima Generale Italiana dei Telefoni, of Naples, who will exhibit a fine collection of lighting apparatus and telephones; Alessandro Lucchesini and Jules Lorenzetti, of Florence, telegraphic apparatus; Rialti Vincenzo, of Forli, novelties in incandescent lamps; Dr. Charles Labus, of Milan, laryngofântome for demonstrating laryngoscopic operations; and Dr. Samuele Salaghi, of Rome, electro-thereapeutic apparatus. From France come the Maison Breguet, and L. Sautter, Lemonnier and Co., of Paris. The exhibits of L. Sautter, Lemonnier and Co. will include a lighthouse, eight dynamo machines, ten large reflecting apparatus, and a number of electric lamps. Lazare Weiller, of Angoulême, promises various exhibits in silicium, phosphor bronze, and copper wire, and Ch. Ferd de la Roche, Paris, regulators and incandescent lamps. Switzerland will have a prominent representative in Emil Bürgin, Basel—the Swiss Edison—who announces, in connection with the London firm of R. E. Crompton and Co., important novelties. From Denmark come Paul la Cour, Askovhus, and Wilhelm Helle, sen., of Copenhagen, inventor of an interesting telephone. Germany will be represented by Keiser and Schmidt, Berlin; the Rheinische Electricitätsgesellschaft, Mannheim, new patented lamps; C. H. F. Müller, Hamburg, electric lamps and Crookes' apparatus; and Heilmann-Ducommun and Steinlen, Mühlhausen. Dr. Emil Boettcher, Leipsic, promises four new secondary batteries; Josef Zimber, Furtwangen (Baden), electric clocks; Michael Sendtner, Munich, electric thermometers; Greiner and Friedrichsat Stützerbach, Thüringen, incandescent lamps; Dr. Greitner's Argentan, Auerhammer (Saxony), metallic cables, plates, &c., for electric purposes; E. M. Reiniger, Erlangen, electro-medical apparatus; Dr. Albert Lessing, Nürnberg, electric coils and apparatus; Dr. Johann Wilckens, Bremen, type-printing telegraph of the deceased inventor G. J. Droste; and Spiecker and Co., Cologne, dynamo-electric machines for the purposes of electric lighting and transmission of power.

**The United Telephone Company v. Hebden.**—On the 22nd of last month Mr. Justice Fry, of the Chancery Division of the High Court of Justice, it may be remembered, made an order committing the defendant in this action to prison for contempt of Court in not obeying an injunction restraining the infringement of the plaintiff's patent for Bell's receiver and for the delivery up of instruments. On that occasion the defendant appeared in person and was subsequently lodged in prison. Mr. Renshaw on Saturday last moved to obtain his discharge on certain affidavits. Mr. Moulton, for the company, said they left the matter in his Lordship's hands, but thought it desirable to point out discrepancies in the defendant's evidence. Mr. Justice Fry said if the defendant had come to him with a simple apology and expression of regret, he should have had no hesitation in discharging him; but instead he had thought fit to file an affidavit with a view to justify and explain his conduct. In his Lordship's view, that affidavit was entirely false, and was a repetition of his previous offence—namely, making a false affidavit to deceive the Court. He thought this a similar attempt and should make no order on this application, except that the defendant should pay the costs. Later news announces Mr. Hebden's release.

**Dentistry and the Electric Light.**—At the annual meeting of the Odonto-Chirurgical Society of Edinburgh, held last Tuesday, Mr. W. B. MacLeod communicated "Notes on Electric Light in Dental Surgery." He said there was no doubt that a clear, steady, and diffused light, capable of being located within the cavity of the mouth, would be a very great advantage to dentists generally. To those whose misfortune it was to practise their profession in cities which were frequently visited by fogs it would be a still greater boon. Attention had for some time past been directed to electricity as a commercial source of light, and it might now be looked upon as one of our standard sources, although not yet quite ready to supplant its older rivals, gas and oil. In their specialty attempts had been made to render it available, and with some degree of success, as was demonstrated by the two appliances now on view before them. The means for securing a constant supply of power yet required further development, means by which the power would be available at a moment's notice and at the same time comparatively cheap before they could hope that it would be adopted generally in the profession. The battery as a source of power was open to the objections of inconstancy, wastefulness, and the need of careful and constant provision.

These faults were certainly considerably modified if besides the light the dentist used the mallet or motor, and thus having the battery in more constant use, utilised the decomposition of materials which continually went on after the battery was charged. What they wanted was an accumulator in which the power might be stored and drawn from whenever required, and from which none would escape when not in use; or a small dynamo which would generate it cheaply when wanted, or a general depôt from which they could have a wire and turn it on when desired, as they did gas. These were still in the future, and those who wish to avail themselves of the electric light in dentistry must in the meantime be content with the D'Or battery or Fuller's bichromate battery. The lamp exhibited was a small Swan of four ohms resistance, and the batteries were each made up of four cells. Mr. MacLeod recommended the Fuller as being the more cleanly and the less wasteful, and having the greater constancy.

**Telegraphic Extension.**—The fishery breeding establishment at Howietoun (Scotland) has now become of so much importance that Sir J. R. Gibson-Maitland has arranged with the Post-office for a telegraph wire from Stirling to the hatchery, which will greatly facilitate the extensive business carried on in supplying fertilised ova and young fish for the stocking of lochs and rivers.

**Royal Scottish Society of Arts (Edinburgh).**—At the ordinary meeting of this society, on Monday, among other communications made was one on the "Electric Valve Closing Apparatus," invented by Mr. Tate, of Bradford. The invention, it was stated, is in use at Dundee.

**Interrupted Telegraph Lines.**—The following is a list of the telegraph lines at present interrupted:—Callao to Mollendo; Falmouth to Bilbao; Odessa to Constantinople; St. Croix to Trinidad; Land lines in Upper Egypt; Land lines in Venezuela.

## OFFICIAL RETURNS OF ELECTRIC COMPANIES.

**Swansea Telephonic Exchange Co. (Limited).**—The return of this company, made up to the 5th inst., was filed on the 12th inst. The nominal capital is £5,000, in £10 shares. The whole of the shares are allotted and a call of £7 10s. per share has been made thereon. The calls paid amount to £3,785, leaving £17 10s. unpaid. Registered office, 59, Wind Street, Swansea.

## NEW COMPANIES REGISTERED.

**Consolidated Electric Company (Limited).**—Capital £100,000, in £1 shares. Registered office, 110, Cannon Street. Objects: The general business of an electric company. Signatories (with one share each), G. S. Fleet, Stratford; C. J. Vollhardt, 29, Villiers Street; H. J. Bass, 13, Henrietta Street, Covent Garden; F. W. Hall, 145A, Drummond Hall, S.E.; J. A. Eaton, C.E., 23, Queen Victoria Street; C. Selby, 23, Queen Victoria Street; and H. A. Mallyon, 5, Great Winchester Street. An agreement to be made between Messrs. J. S. Beeman, Wm. Taylor, Frank King, the South Eastern (Brush) Electric Light Company (Limited), the Provincial (Brush) Electric Light Company (Limited), and the present company will be adopted. Directing qualification, £250 (nominal) in shares or stock. The first directors are Sir Michael Kavanagh Kennedy, R.E., Messrs. Francis Fesser, R. Cunningham, T. Fry, J. Kincaid, J. Paxman, H. T. Sankey, and C. Wapshawe. Each director will be entitled to £100 per annum if not also a director of either the South Eastern or the Provincial Companies; but all the members of the board may participate in one-third of the surplus profits remaining after payment of £12 per cent. per annum dividend. Registered 8th inst. by Walter Webb and Company, 23, Queen Victoria Street.

**John Northam and Company (Limited).**—Capital £500, in £5 shares. Objects: To erect, maintain, and work wires and appliances whereby signals may be transmitted, electrically or otherwise, from clubs, hotels, private houses, manufactories, mines, and other places, for rendering buildings secure against attacks by burglars, fire, lightning, &c. Signatories: J. Doyle, 5 shares; W. Johnson, 5 shares; R. Winter, 5 shares; A. H. Procter, 5 shares; W. Jackson, 4 shares; F. Eaton, 3 shares; H. Flint, 2 shares; T. Hodgkinson, 2 shares; R. Winter, junr., 2 shares; G. Bramhall, 1 share; all of Sheffield. Registered 12th inst.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

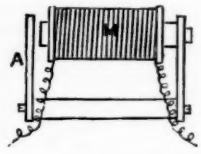
3019. "Electric sock for boots and shoes." F. W. WOODMAN and T. W. AYLESBURY. Dated June 26. 2d. Has for its object the application of electricity for curative or remedial purposes and consists in an improved construction of sock to be placed in boots and shoes for generating currents of electricity when excited by the moisture of the foot. The sock is constructed of one or more galvanic pairs of a form corresponding to the shape of the foot, and in two or more pieces so hinged or jointed together as to possess the requisite degree of flexibility to enable it to yield to the foot in walking, each pair being constructed of a plate of zinc and a plate of copper, the edges of the one plate overlapping and embracing those of the other, so that the two plates will be securely held together!!! (*Provisional Protection not allowed.*)

3128. "Electric logs." R. M. LOWNE. Dated July 3. 6d. Consists of an improved method of insulating electrical conductors under salt water, and of making and breaking an electrical circuit under salt water or otherwise, and has for its object improvements in apparatus for recording by electricity the number of revolutions of a rotator which may be placed under fresh or salt water, and at any convenient distance from a recording apparatus.

3273. "Magnets." J. S. FAIRFAX. Dated July 10. 2d. Relates to a novel construction of permanent and electro-magnets, whereby greater efficiency and more convenient forms may be obtained. By this invention magnets may be wholly or partially constructed of filings, or other small pieces of metal divided in any suitable way, and arranged in any suitable form, and the said particles may be either placed within a case or shell, or, if an electro-magnet, within a coil of wire; and if more convenient, combined with solid bars, plates, wires, pole pieces or keepers, as required, and used for any purpose for which a magnet is applicable. (*Provisional only.*)

3279. "Electric lamps." J. S. BEEMAN. Dated July 11. 4d. The improvements relate to electric incandescent and arc lamps or lights, and consist, as regards incandescent lamps, in the use of mica or talc, with or without reflectors or reflecting surfaces, in the construction of such lamps. The inventor takes mica or talc, or other non-conducting semi-transparent matter of convenient size and thickness, and uses it to act, in case of necessity, as a support or supports for the carbon filament, and so neutralises leverage, and, by acting as a non-conducting diaphragm, tends to arrest the deposit of carbon particles on either side or on various parts of the filament as at present; and in some cases to act as a reflector in addition, by plating parts of the mica or otherwise treating it to give it a reflective surface, or by using in combination silvered glass, or metal, or other reflectors. And as regards arc lamps, the invention consists in using the mica or talc as a shield or tube round or about the arc points to arrest, and if necessary to collect also the sparks, and prevent the passage of flame.

3335. "Telephones." S. M. YEATES. Dated July 14. 6d. Consists in improvements in telephones and instruments for the reproduction of articulate speech and musical sounds, and is designed to affect the construction of telephone receivers, so that the sounds produced are loud and clear, without the intervention of a tympanum or diaphragm. The figure shows an electro-magnet, M, and armature,




A, the electro-magnet being fixed at one end as shown. The electro-magnet and armature thus constructed is mounted on a suitable resonant board or box, by which means the sound produced is greatly augmented, while at the same time the box forms a convenient stand or handle for the instrument.

3339. "Arc regulator lamps." R. E. B. CROMPTON. Dated July 14. 6d. Relates more particularly to the improvement in electric lamps described in inventor's provisional specification, No. 346, on the 24th of January of the current year, and is applicable in cases where the upper and lower carbon carriers are connected together by cords, chains, or other suitable flexible connection, passing over pulleys so arranged that the travel of each carbon is controlled by the other. In one arrangement the inventor causes one portion of the connecting cord to gear with a sheave or pulley mounted on the same axis as the first wheel in the train of the gearing frame, described in the above-mentioned provisional specification. This gearing-frame is connected to an electro-magnet or solenoid in such manner that it rises and falls according to the degree of magnetisation of the armature or of the core of the solenoid. By this rising and falling it advances or retires the carbons affixed to the connecting cord, and regulates the length of the arc.

3349. "Incandescent electric lamp appliances." J. S. BEEMAN. Dated July 14. 6d. Consists of a lamp-holder fitted with a stud or studs, intended to slide in a slotted case or receptacle, furnished with a locking ring for fastening the sliding holder, and with contact plates, which are connected with springs interposed between the bottom of the lamp and the bottom of the inside of the receptacle, or plates, impinging upon a switching apparatus; also in forming the communication between the contact plates and the carbon filament by means of an adjusting spring or springs, and spiral, serrated or corrugated metallic wires or ribbons. Also in forming the switching apparatus with a contact breaker on one lead and a metal band and contact pieces giving continuous electrical connection on the other.

3350. "Electric lamp holders, &c." J. S. BEEMAN. Dated July 14. 8d. The improvements consist in making the holders telescopic, and making contact by means of a spring, or springs, wheels, or contact pieces fitted in or on the inner tube or casing holding conducting wires, such springs or pieces being allowed to impinge or touch the inside of the outer case, which may be made to slide if desired—and is put in electrical contact with the electric current, thus making a sliding electrolier and one that can be turned about its axis—the inner casing of the outer tube being in the reverse electrical state to a centre rod passing into the inner tube or case which carries the contact springs or equivalents, or these may be placed on the outer tube. As regards switches, the invention consists in a double break contact, so shaped that the switch must be worked in one direction, and be either full in action or fully off—in one case by making the movable parts in the shape of a double cam, and in another the movable parts furnished with springs to work into or on double shoulders or hollows. Also in making switches for cutting a portion of a circuit with contact springs acting direct on contact movable surface.

3351. "Apparatus for automatically shunting electric currents and breaking circuits." J. S. BEEMAN. Dated July 14. 6d. The object of the invention is to produce an apparatus for shunting electric currents from one circuit to another, or from one part of a circuit to another part, and the improvements consist in attaching to the circuit, or circuits, a hollow coil of insulated wire, in the hollow of which is a soft iron bar which has a contact part, and which, when the current is on, is drawn up into the hollow, and when this current ceases to act through part of the circuit being broken, falls and completes another circuit. The apparatus for breaking circuits consists of two springs held in tension by the usual lead or fusible metal connection, so that when the current is too strong the lead or other fusible material melts and the springs fly apart and break the circuit. Also in making a circuit breaker between two metal plates by means of a bar of fusible metal, held in position and contact with said two plates by a spring or springs.

3355. "Apparatus for supplying electricity for light, power, &c." T. J. HANDFORD. (Communicated from abroad by T. A. Edison.) Dated July 14. 8d. The object of this invention is to produce simple and efficient means for supplying with current the electric lights, motors, or other translating devices, of a system, more or less extensive, such lights or motors being in separate multiple arc or independent circuits, and utilising a current of high tension in the main conductors so as to reduce the investment for copper in such main conductors.

3370. "Apparatus for automatically indicating the presence of fire or heat by means of electricity." E. EDWARDS. (A communication from abroad by B. Carré, of France.) Dated July 15. 6d. Has for its object improvements in the construction and arrangement of apparatus by which automatic indications are given at any distance and at any desired places of the presence of fire, or of heat above a certain temperature, in houses, theatres, or other places.

3382. "Electric light appliances." H. J. HADDAN. (A communication from abroad by H. A. Seymour, of America.) Dated July 17. 1s. Relates to electric light appliances and is sevenfold in its nature, the first part of the invention comprehending an improvement in arc lamps; the second part an improvement in towers for supporting electric lights, the third part an improvement in switching systems, the fourth part an improvement in incandescent lamps, and the fifth, sixth, and seventh parts improvement in carbons for incandescent lamps.

3303. "Secondary voltaic batteries." F. W. DURHAM and P. WARD. Dated July 12. 4d. According to this invention the inventors form what may be called a plate of a secondary voltaic battery in the following manner. They draw the lead or other metal into the form of pinion wire—that is to say, wire such as is used for the pinion of clocks or watches. They then on a rectangular frame, which may be of the same metal, wind this wire lengthwise or crosswise, or both, so as to form a kind of compound web, every strand of which presents a surface of great extent in proportion to its weight.

3318. "Appliances for producing, evolving, collecting, storing, and utilising electric energy for lighting, &c." I. L. PULVERMACHER. Dated July 12. 6d. The object of the invention is improved means and appliances or apparatus for producing or evolving, collecting, storing, and utilising electric energy for lighting, and for general purposes, partly applicable for use in combination with coal gas.

3322. "Apparatus for producing, measuring, and distributing electric currents." J. M. M. MUNRO. Dated July 13. 10d. This invention has for its object to improve and render more efficient and satisfactory apparatus employed for producing, measuring, and distributing electric currents. In constructing dynamo machines for producing electric currents, it is sought by this invention to arrange the active surfaces of the field-magnets so as to surround to a greater extent, than in ordinary machines, the coils of the rotating armature or armatures; and in carrying out this part of the invention the iron cores of the armatures may rotate or be stationary, or they may in some cases be dispensed with.

3331. "Apparatus for making and breaking electric circuits." J. R. GIBSON. Dated July 13. 2d. The object of this invention is to obtain any number of pre-arranged contacts from one starting impulse. This is done by the use of a metal ball rolling in an endless path by its own gravity from a higher to a lower level, and touching in its course contact surfaces, thereby completing any number of circuits corresponding to the number of pairs of contact points over which it rolls. (*Provisional only.*)

3385. "Electric arc lamp." L. A. GROTH. (Communicated from abroad by C. P. Jürgensen, of Denmark.) Dated July 17. 6d. Relates to the lamp described in the No. of the ELECTRICAL REVIEW for Sept. 23rd, 1882.

3419. "Dynamo-electric machines." S. Z. de FERRANTI, and A. THOMPSON. Dated July 18. 6d. Relates to the machine described in the No. of the ELECTRICAL REVIEW for Dec. 2nd, 1882.

3430. "Application of telephones or microphones to pipes or vessels to detect leakage." A. Q. ROSS. (Communicated from abroad by T. J. Bell, of America). Dated July 19. 6d. Relates to the application of any known telephonic or microphonic apparatus, for detecting leaks in pipes or vessels, containing and conveying under pressure liquids, fluids, gasses or air, either underground or otherwise, but more especially for detecting leaks in service pipes supplying cities, towns, or villages, with water or gas. In carrying out the invention the inventor avails himself of the well known conductivity of continuous lines of metal, such as water-pipes for sound vibration; the escape of water under pressure from mains or service pipes producing a sound more or less distinct, according to the head or pressure of water, the size of the leak orifice, and the distance between the same from the point of observation (that is the length of pipe through which the sound is conducted); by the employment of a telephonic or microphonic apparatus suitably constructed for concentrating and amplifying the sound variations thus transmitted through the pipes from the point of escape; leaks of even a minute character may be ascertained and located with accuracy.

3409. "Plates for secondary batteries." W. TAYLOR and F. KING. Dated July 18. 2d. Relates to an entirely new form of plate or electrode for secondary batteries. The plate is composed of a continuous tape of lead by a suitably-constructed machine. The lead is cut into a tape of any width or substance, and wound into a plate at one and the same time. The manufacture or construction of the plate is thus produced automatically. The lead upon leaving the cutting tool is allowed to pass through a vessel containing red lead, or minium mixed with sulphuric acid, or with any salts of lead, or lead in a finely divided condition. By this means the tape is covered with a thick coating. This latter operation can be dispensed with by cutting the lead tape very thin. The advantages of this form of plate are the easy method of construction, the great amount of working-plate surface obtained, the great number of plates that can be placed in one trough, and the ease with which the plates can be removed and replaced in case one of the plates should in any way become injured. The centre of the plate is a piece of lead round which the tape is wound. When the required size is obtained, a moderately stout lead frame is shrunk round or over. The angles of the four corners of the tape-made plate are then burnt together, which fastens the tape and gives it rigidity.

5279. "Clocks for signalling by electricity." W. R. LAKE. (Communicated from abroad by the Standard Time Company (incorporated), of America.) Dated November 4. 6d. Relates to improvements in and in connection with clocks for transmitting electrical signals at a predetermined time or times. There is a common and well-known device in connection with a clock, whereby, at a certain time, one of the pointers to which one of the conductors of an electrical circuit is connected is brought into contact with a metal surface which is connected with the other conductor so as to complete the circuit, and while the pointer is in connection with this said surface and the circuit is thereby closed, the signal will continue, but a difficulty is experienced in this class of signals because of the variableness in the time at which the circuit is closed or broken, owing to the irregular approach of the pointer to, and escape from, the said circuit closing surface. In the usual devices it is impossible to adjust this surface so as to make the time of the signal longer or shorter. The object of the said invention is to overcome these difficulties, and it consists essentially in arranging the surface upon which the circuit is completed in such relation to the pointer, that contact between the said pointer and the surface will be sudden and instantaneous, and its escape therefrom alike sudden and instantaneous, and in making the said surface adjustable as to its extent, as hereinafter described. Fig. 1 is a front elevation of a portion of

FIG. 1.

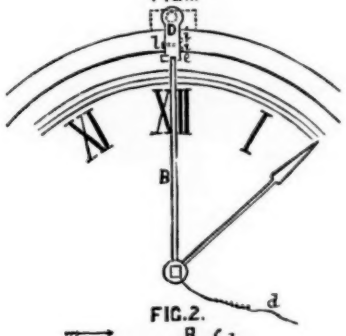
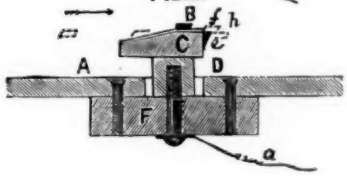



FIG. 2.




a clock dial embodying this invention. Fig. 2 is a transverse section drawn to an enlarged scale. A, represents the clock dial, B, the pointer by which the contact is made (this may be one of the pointers of the clock, or an independent pointer). In the path of the said pointer, and at a point where the signal is to be given, say at twelve o'clock, a block, C, of ebonite or other suitable non-conducting material is secured to the dial, or to some stationary part of the clock. In fig. 2 the block, C, is shown as attached to a metal piece, D, and the piece, D, is secured by a screw, E, and insulated from the dial plate or that part of the clock movement with which the pointer is in connection by an ebonite block, F, or the like on the rear of the plate, A. The front surface of the block, C, is inclined as shown in fig. 2, so that the pointer, B, as it approaches the said surface, will move up the incline, and thus be thrown out of its ordinary plane of movement. On the side of the metal piece, D, to which the block, C, is attached is a metal arm, *e*, the surface of which stands a little below the front face of the block, C. The pointer, B, moves over the block, C, until it comes to the edge and can escape from the surface of the said block; as soon as it escapes from the said surface it springs down or backwards and into contact with the arm, *e*, as shown in dotted lines at *f*, fig. 2. One wire, *a*, of the electric circuit is suitably connected with the arm, *e*, through the screw, E, by means of which the metal piece, D, is secured to the plate A; the other wire, *d*, is connected to the central shaft or to some other point of the clock, so that the pointer, B, becomes a continuation of that line. As the pointer strikes the surface of the arm, *e*, the circuit is closed, and will remain so as long as the pointer is in contact with that surface. The outer edge of the arm, *e*, is made very thin by under-cutting, as shown in fig. 2, and the rear edge of the pointer is correspondingly bevelled or cut, hence as soon as the rear edge of the pointer arrives at the edge of the arm, *e*, it will spring backward, as shown at *h*, fig. 2, and owing to the corresponding incline of the pointer and the arm, *e*, the escape of the said pointer from the surface of the said arm is instantaneous, so that there is no dragging or delay in the breaking of the circuit. The arm, *e*, is made adjustable on the metal piece, D, so as to be moved nearer to, or farther from, the block or point where the circuit is closed; this is accomplished by means of two screws, *i i*, extending through the said arm into the piece, D, and an intermediate screw, *l*, upon the opposite side, bearing against the said arm, so that by unscrewing the screws, *i i*, and screwing in the screw, *l*, the arm, *e*, will be correspondingly moved away from the point of the block, C, where the pointer escapes, or *vice versâ*, the further the outer or escapement edge of the arm, *e*, is from the block or point where the circuit is closed, the longer will be the time during which the circuit will remain closed and consequently the longer the signal.

# CITY NOTES, REPORTS, MEETINGS, &c.

## The Western and Brazilian Telegraph Company (Limited).

AN extraordinary general meeting of this company was held at St. Michael's Hall, George Yard, Lombard Street, E.C., on Thursday, Sir H. Drummond Wolff, M.P., the chairman of the company, presiding.

The Chairman: I will detain you as short a time as I can in bringing before you the business of the present meeting. In the first place I shall have to propose that a dividend be declared at the rate of 3 per cent. on the (reduced) capital of the company, to which resolution I suppose no opposition will be raised, and after that certain resolutions will be submitted to you by a shareholder with regard to the division of the shares. I should merely wish to say a word with regard to this proposed division. On a former occasion, at the request of certain shareholders, these resolutions were submitted to you and great objection was raised to them by various shareholders, who brought forward arguments against the division of the shares. We had a very large number of proxies in our possession, but in consequence of the opposition manifested at the meeting the directors thought that they would not be justified in using these proxies, although the shareholders had had the subject very fully put before them. Afterwards a number of shareholders, in accordance with the statute holding a certain number of shares, requisitioned the board to bring the question before a general meeting of the shareholders, and I may say, without expressing any opinion on the subject one way or another, that the directors had no alternative but to call a meeting and submit the resolutions to you, thus affording you an opportunity of giving your views. The directors desired to put the question fairly before the proprietors, as in our opinion it is a question for the shareholders and not for the directors. The duties of the board are to manage the affairs of the company, and not to divide or propose alterations in the shape in which the property is held; but these shareholders, holding over 11,000 shares, and the necessary statutory number, sent to us a requisition, and we determined to give every shareholder an opportunity of saying what he considered right in the matter. Without going into any question of statistics, I may say the proxies in favour of the resolution are about five times more numerous than those against it. The directors have exercised no influence to procure that result, and we have now no alternative but to make use of these proxies. I now move that a dividend be declared of £3 per cent. on the (reduced) capital of the company in accordance with the recommendation contained in the annual report, dated January 3rd, 1883.

Major Wood seconded, and the resolution was unanimously carried.

Mr. Herring moved:—"That the directors may, subject to such restrictions and on such terms as hereinafter mentioned, agree with any holder of existing ordinary shares of the campany for the conversion of the shares held by such holder into preferred ordinary shares and deferred ordinary shares, as hereinafter defined, that is to say:—(A) Preferred and deferred ordinary shares shall be issued only in substitution for paid-up existing ordinary shares and by way of division of ordinary shares into two equal shares of £7 10s. each. (B) Such division may be made at any time between the 1st day of January and the 30th day of April in any year, on the request in writing of the holder of paid-up existing ordinary shares. (C) The certificates for any of the existing ordinary shares to be divided into preferred and deferred ordinary shares shall, before such division, be delivered up for cancellation, and the directors shall issue certificates for preferred ordinary shares and deferred ordinary shares, distinguishing the same from the existing ordinary shares. (D) The holders of preferred ordinary shares and deferred ordinary shares shall remain together entitled, subject as hereinafter mentioned, to the same proportion of the net profits in each year available (having regard to the regulations from time to time of the company) for dividends for that year, as the holders of such existing ordinary shares as shall have been exchanged for and divided into such preferred ordinary shares and deferred ordinary shares would have been together entitled to receive by way of dividend for that year, if no such exchange and division had been made, and no other profits shall be considered as available in any year for dividends on the preferred ordinary shares and the deferred ordinary shares notwithstanding the rights to preference *inter se* hereinafter mentioned. (E) The net profits, available as aforesaid in each year, for dividends on the preferred ordinary shares and the deferred ordinary shares shall be applied in the first place in payment of a cumulative dividend of £5 per cent. per annum to the holders of preferred ordinary shares, *pari passu*, in priority to any payments to the holders of deferred ordinary shares, such cumulative dividend to be computed from the 1st day of October next preceding the division of the shares, and the surplus (if any) shall be applied in payment of dividends to the holders of deferred ordinary shares, *pari passu*, at such rate as the net profits available aforesaid shall suffice to pay. (F) The rights, privileges, qualifications, and liabilities of holders of preferred ordinary shares and deferred ordinary shares, shall, as between them and the holders of the existing ordinary shares remaining unexchanged, and as between themselves (subject to the preference as to dividend aforesaid), remain the same as if the preferred ordinary shares and the deferred ordinary shares had remained part of the existing ordinary shares. (G) For the purposes of directors' qualification under Article 21, calling a general meeting by requisition under Articles 52 and 53; demanding a poll under Article 67, or voting under Article 70, two shares whether preferred or deferred or preferred and deferred, shall be computed as one share, and every holder of preferred or deferred shares shall accordingly have in respect of such shares only one vote for every two shares held by him." He did not think he ever proposed a resolution with greater pleasure. The division of the shares could do no possible harm, but might do a great deal of good, and he could not conceive that any shareholder who had carefully thought over the proposition would vote against it.

Mr. Wood seconded.

At the request of Mr. Burt, the chairman read the requisition and the names affixed to it, and it was intimated that no Stock Exchange gentleman had signed the document.

Mr. Burt asked if there was any precedent for dividing the shares into preferred and deferred shares, so that the preferred should be cumulative.

Mr. Bompas replied that he advised the board to have a cumulative dividend, as with it there was no competition between the holders of the two classes of shares. Without it there was a rivalry between the preferred and deferred shareholders, each trying to get a larger dividend in a particular year.

Mr. Burt: Have you a precedent?

Mr. Bompas: Yes, in railway shares.

Mr. Burt: Can you give me an instance?

Mr. Bompas: The Great Northern "B."

Mr. Burt would like to say a word or two. He had an interest in the matter, and he believed it would be a great mistake to divide the shares. The chairman had said that it was a matter for the shareholders, and not for the directors. He thought they would very soon find it was a matter for the directors, and that the directors would regret such a division. He differed from Mr. Bompas as to the cumulative dividend. Mr. Bompas would find that the general law was distinctly against a cumulative dividend. He was satisfied the directors would discover that instead of having a united body of shareholders as they had at present, having one interest, and supporting the directors unitedly, they would have two classes, each with equal votes, but having very different interests in the company. The deferred share would give an equal vote to the preferred; one was worth £5 or £6, and the other about £1.

A Shareholder: the voting power might be modified.

Mr. Burt, continuing, said if the board had thoroughly considered the matter and made up its mind upon the subject, probably it was not worth discussing it, but he knew by the experience of another company that the division of ordinary shares into preferred and deferred shares had produced anything but good results. There were gentlemen on the Stock Exchange interested in the deferred shares who might endeavour to raise or depress the price of the shares as suited them; and there were gentlemen connected with the Stock Exchange who were in the habit of taking advantage of accidental circumstances to raise or depress the price of the shares for their own purposes. He was very sorry to hear that the number of votes in favour of the resolution was so much greater than those against it. He should have been glad if the directors had advised the shareholders on the subject. He did not think, as he had said, that it was a good thing to divide the shares: on the contrary, he thought it would bring trouble, especially to the board. The two conflicting interests would, in his opinion, be of disadvantage to the board under many circumstances.

Mr. Wood remarked that, as he happened to second the resolution, he might as well say he had no connection with the Stock Exchange, and that he voted against the resolution at the last meeting. He now, however, thought it might be for the general interest of the shareholders, and therefore supported it.

Captain Cotton said the chairman had before mentioned to them that, having put their house in order at home, he would fain hope that they might enter into negotiations with the Brazilian Government. He should like to know whether anything was being done in the matter; if so, he thought it would be advisable to postpone passing the resolution until they knew the result of the negotiations (hear, hear).

The Chairman replied that at the present moment the negotiations were in abeyance, but he could not conceive that that resolution would interfere with any purchase or arrangement by the Brazilian Government. In answer to Mr. Burt, he did not wish to place the directors in the position of having either to defend or to attack the present proposal. They considered in January that they were more than justified in submitting the resolution to the general meeting from the very influential and powerful representations that were presented to them by shareholders. These were so numerous and so repeated that they should certainly not have been doing their duty had they not submitted it to them. Since then they had received the requisition. They had nothing to do with the professions of those who might have signed it. As shareholders, they had a right to send in a requisition whatever profession they might belong to. The question had been before the shareholders for nearly three months, and they had had ample opportunity of considering it. He might add that whenever an arrangement was proposed by the Brazilian Company it would be for the shareholders to say whether or not they would sanction it.

Mr. Herring was in hopes that they would have been unanimous. They who supported the resolution said "Divide the shares; we wish it; give us £7 10s. preferred and £7 10s. deferred; and let any gentleman who likes hold his £15 share. We do not want him not to." For his £15 share Mr. Burt had a vote, and for his one preferred and one deferred he (the speaker) would have a vote. If the Brazilian Government paid them £1,500 or £15,000,000 Mr. Burt got his million and he (the speaker) got his million, or whatever amount it might be. Where was the harm in that?

The resolution was then put, and carried by 14 to 7.

A poll was demanded, the result of which was that the votes recorded by proxy and by persons present numbered 22,214 for the resolution and 4,322 against it.

The Chairman accordingly declared the resolution carried.

A vote of thanks to the chairman and directors concluded the meeting.

---

**The Brazilian Submarine Telegraph Company (Limited).**—The directors have declared an interim dividend of 3s. ber share, or 6 per cent. per annum, free of income-tax, for the puarter ended December 31st last, payable on the 22nd inst.